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The Contribution of Kenai River Coho Salmon to Commercial Fisheries of Upper Cook Inlet, Alaska in 1993

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December 1994

Alaska Department of Fish and Game

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ABSTRACT

The contribution of Kenai River coho salmon *Oncorhynchus kisutch* to commercial fishery harvests of Upper Cook Inlet was estimated for the first time in 1993 based on recoveries of adults marked as juveniles with coded wire tags. The drift gill net and the eastside set gill net fisheries of the Central District were examined during the period when 95% and 91% of the respective total harvests occurred. An estimated 1,040 and 6,472 Kenai River coho salmon were harvested in the drift gill net and eastside set gill net fisheries, respectively. These harvests represented 1% of the drift gill net harvest (117,924 coho salmon) and 17% of the set gill net harvest (38,725 coho salmon) during the period sampled. The Kenai River contribution comprised a considerably lower proportion of the total harvest than expected. The majority of the harvest was comprised of stocks of unknown origin.

Contribution estimates were stratified by date for both fisheries and additionally by statistical area for the eastside set gill net fishery. No significant trend in contribution was evident in the drift gill net harvest because of the low contribution estimate. Estimated contributions to the eastside set gill net harvest ranged from 0% to 52% among four statistical areas and during four sampled periods. There was an increasing trend in the contribution to the harvest in each statistical area over time. During the sampled period, there was an increasing trend in proportional contribution and a decreasing trend in total harvest from the northernmost statistical area to the southernmost.

The most abundant group of marked fish returning to the Kenai River was the cohort marked as smolt at the Moose River in 1992. The proportion of the entire Kenai River return marked at the Moose River was 0.0728. This proportion was estimated by examination of the inriver recreational harvest and served as the basis for estimating contribution to commercial fisheries. The marked proportion remained relatively constant over the duration of the recreational fishery during August and September. This indicates that smolt emigrating from the Moose River are a representative sample of coho salmon from the Kenai River with respect to return timing. The Moose River is therefore a practical site for marking smolt in the future. Based on the marked proportion of 0.0728, the abundance of smolt emigrating from the Kenai River in 1992 was about 1 million. This estimate is biased high due to long-term tag loss. Long-term tag loss for all marked cohorts returning to the Kenai River was estimated as 9%.

A total of 61,769 Kenai River coho salmon were harvested in UCI during 1993: 7,512 in commercial fisheries; 52,828 in the Kenai River recreational fishery; and 1,429 in the Kenai River personal use dip net fishery.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, contribution, commercial harvest, coded wire tags, Kenai River, smolt abundance, tag loss.

INTRODUCTION

Background

Coho salmon *Oncorhynchus kisutch* spawn and rear in freshwater drainages of Upper Cook Inlet (Figure 1). Adults returning to spawn are harvested annually in mixed-stock commercial and recreational marine fisheries. Recreational harvests also occur in fresh water. Upper Cook Inlet (UCI) stocks support the largest recreational harvests and the second largest commercial harvests of coho salmon in Alaska (Figure 2).

In 1991, a stock assessment program was initiated by the Alaska Department of Fish and Game, Division of Sport Fish, to assess the status of UCI coho salmon stocks. Despite the importance of UCI coho salmon fisheries, no comprehensive assessment program existed before 1991. A lack of stock status and general resource information has precluded the development of fishery management objectives. The long-term goal of the assessment program is to provide fundamental information on which to base management objectives and strategies.

Stocks under investigation include hatchery-reared fish released into streams near the Anchorage urban area (Hoffmann and Hasbrouck 1994) and wild fish originating in the Kenai River drainage. Wild stocks from the Kenai River support a growing freshwater recreational fishery that is the largest for coho salmon in the state (Mills 1979-1994). Kenai River stocks also contribute to commercial marine harvests. Although the recreational and personal use harvests are estimated annually by angler surveys (Hammarstrom 1977, 1978 and 1988-1992; Schwager-King 1993; Mills 1979-1994), spawning escapements and commercial harvests of Kenai River coho salmon have not been estimated. Kenai River coho salmon were selected for assessment because of concerns regarding the sizable inriver harvest, the increase in angler effort, and the unknown level of exploitation.

The initial goal of the Kenai River stock assessment program is to reconstruct an annual adult return from its major component parts which are: (1) the inriver recreational and personal use harvests, (2) the spawning escapement, and (3) the contribution to the UCI commercial marine harvest. Because the inriver harvests are estimated annually, concurrent estimates of the commercial harvest and escapement components will provide the first available information regarding run size and exploitation. The first estimates of the stock-specific commercial harvest are presented in this report. Methods for estimating escapement are under investigation in a companion project (Bendock and Vaught *In press*).

Salmon run timing and migration routes through UCI marine waters overlap among species such that commercial harvests are mixed-stock and mixed-species in nature (Ruesch and Fox 1994). Techniques for determining stock contributions to commercial coho salmon harvests have been investigated, but little quantitative information exists. Initial analyses of length-at-age (Wadman *Unpublished*), migratory timing (Tarbox 1988), and scale pattern variables (Bethe *Unpublished*, Robertson *Unpublished*) indicated that these traits may be of value in distinguishing contributing stocks. However, a recent study (Vincent-Lang and McBride 1989) concluded that quantifying stock contributions using these traits is not precise enough to define management objectives.

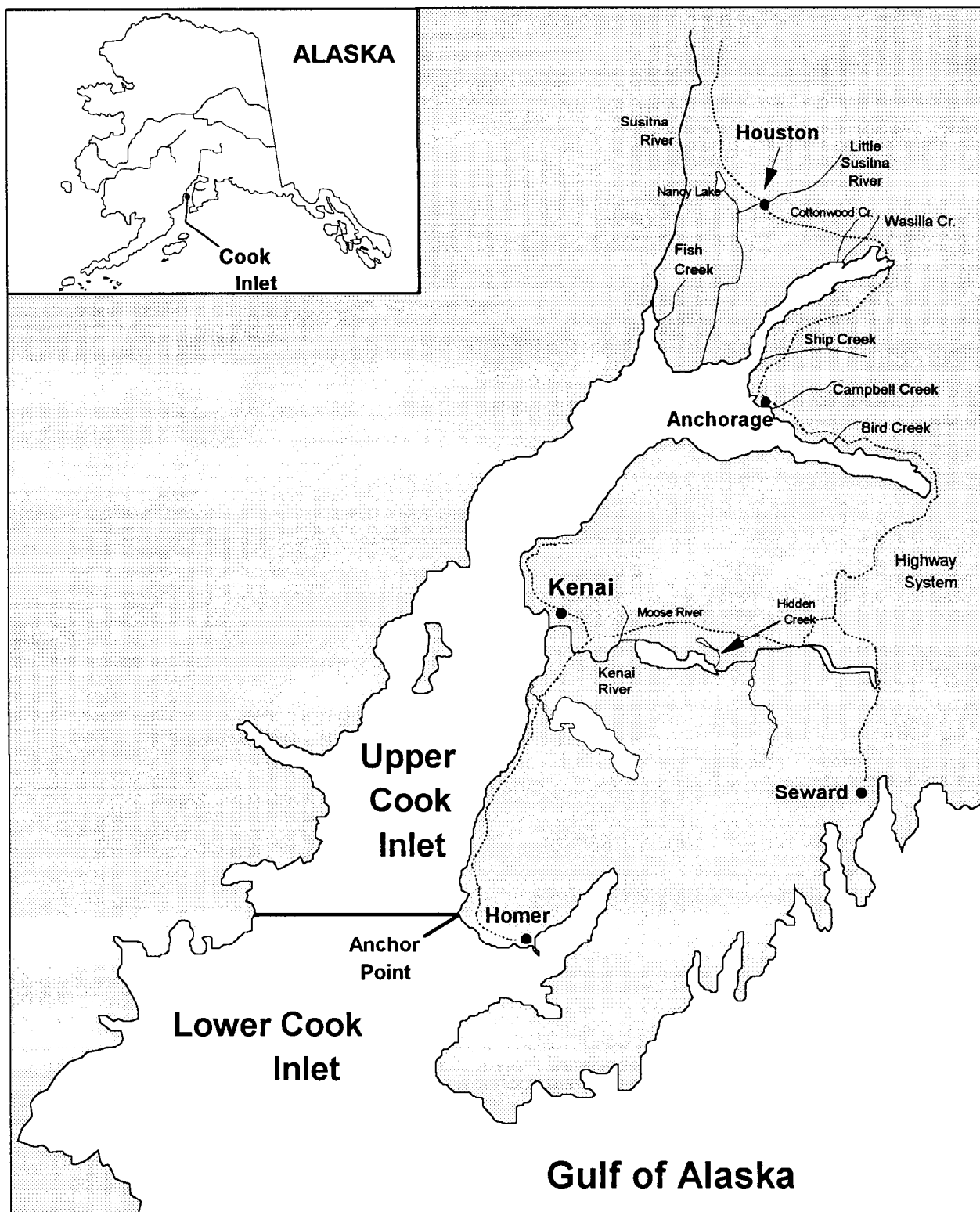


Figure 1. Map of the Cook Inlet basin with selected tributaries.

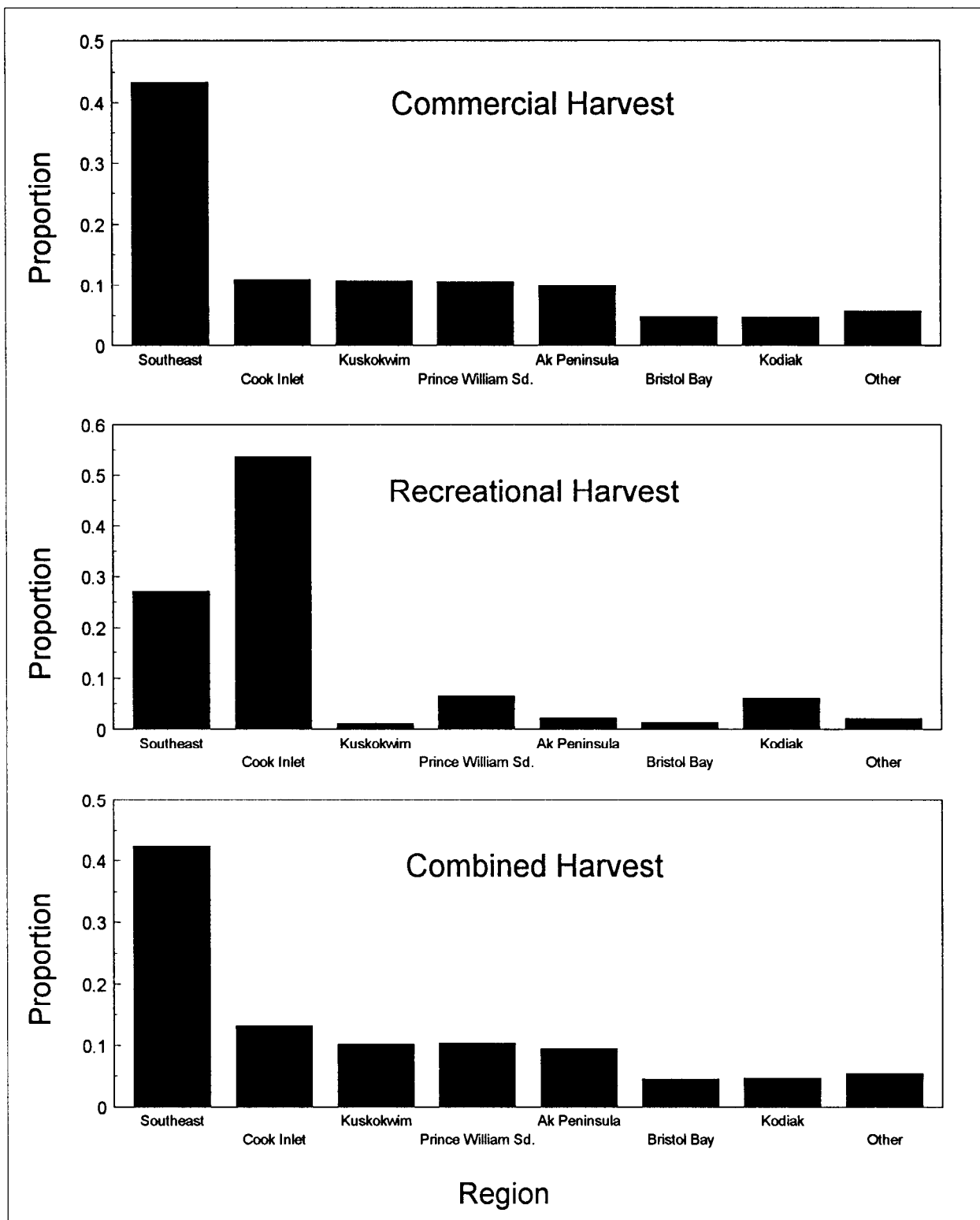


Figure 2. Average proportions of the statewide commercial and recreational harvests of coho salmon by region, 1982-1992 (Sources: Rigby et al. 1991; Mills 1992).

In developing the assessment program, microwire tagging of juvenile coho salmon within the Kenai River drainage was recommended to allow positive identification of returning marked adults in the mixed-stock harvest (Meyer et al. *Unpublished*). Statistical procedures exist for estimating the harvest of contributing stocks based on recoveries of fish marked with coded, microwire tags (Clark and Bernard 1987). These procedures have been applied in commercial (Elliot et al. 1989, Elliot and Sterritt 1990) and recreational (Sonnichsen et al. 1987; Vincent-Lang et al. 1988; Carlon and Vincent-Lang 1989 and 1990) marine coho salmon fisheries in Alaska.

Study Area

Coho salmon fingerling rearing within the Kenai River drainage were captured for marking with coded wire tags (CWT) at the outlet of Skilak Lake in 1991 (Figure 3). Smolt were captured as they emigrated from the Moose River and Hidden Creek tributaries in the spring of 1992. Marked adults returning to spawn in 1993 migrated through the marine waters of Upper Cook Inlet on their approach to the Kenai River. Ten general fishery areas comprise the Upper Cook Inlet Management Area and all fishery areas are comprised of smaller statistical areas for the purpose of catch reporting (Figure 4). The commercial harvest was examined at processing plants and buying stations located along the Cook Inlet coast line from Homer to Anchorage. The recreational harvest from the lower 34 km of the Kenai River was examined as anglers continued to fish and at access locations where anglers landed their harvest.

Objectives

The drift gill net and the eastside set gill net fisheries occurring in the Central District of Upper Cook Inlet account for a major portion of the annual commercial coho salmon harvest. Due to the proximity of the Kenai River to these fisheries, it has been assumed that Kenai River stocks comprised a substantial portion of the harvests. The primary objective of this study was to estimate the contribution of Kenai River coho salmon to these two fisheries. Prerequisites to estimating contribution were to:

1. estimate the marked proportion of the adult population returning to the Kenai River during August and September 1993; and
2. test the null hypothesis that the marked proportion remained constant over time.

METHODS

Experimental Design and Assumptions

To identify coho salmon from the Kenai River harvested in the mixed-stock commercial fishery of UCI, a sample of juvenile coho salmon was captured and marked within the Kenai River drainage (Carlon 1992). Fingerling were marked at the outlet of Skilak Lake during the fall of 1991 and smolt emigrating from the Kenai River were marked at Moose River and Hidden Creek during the spring of 1992 (Table 1). Captured juveniles were marked with a coded-wire tag and an adipose finclip. Removal of the adipose fin serves as an external mark to

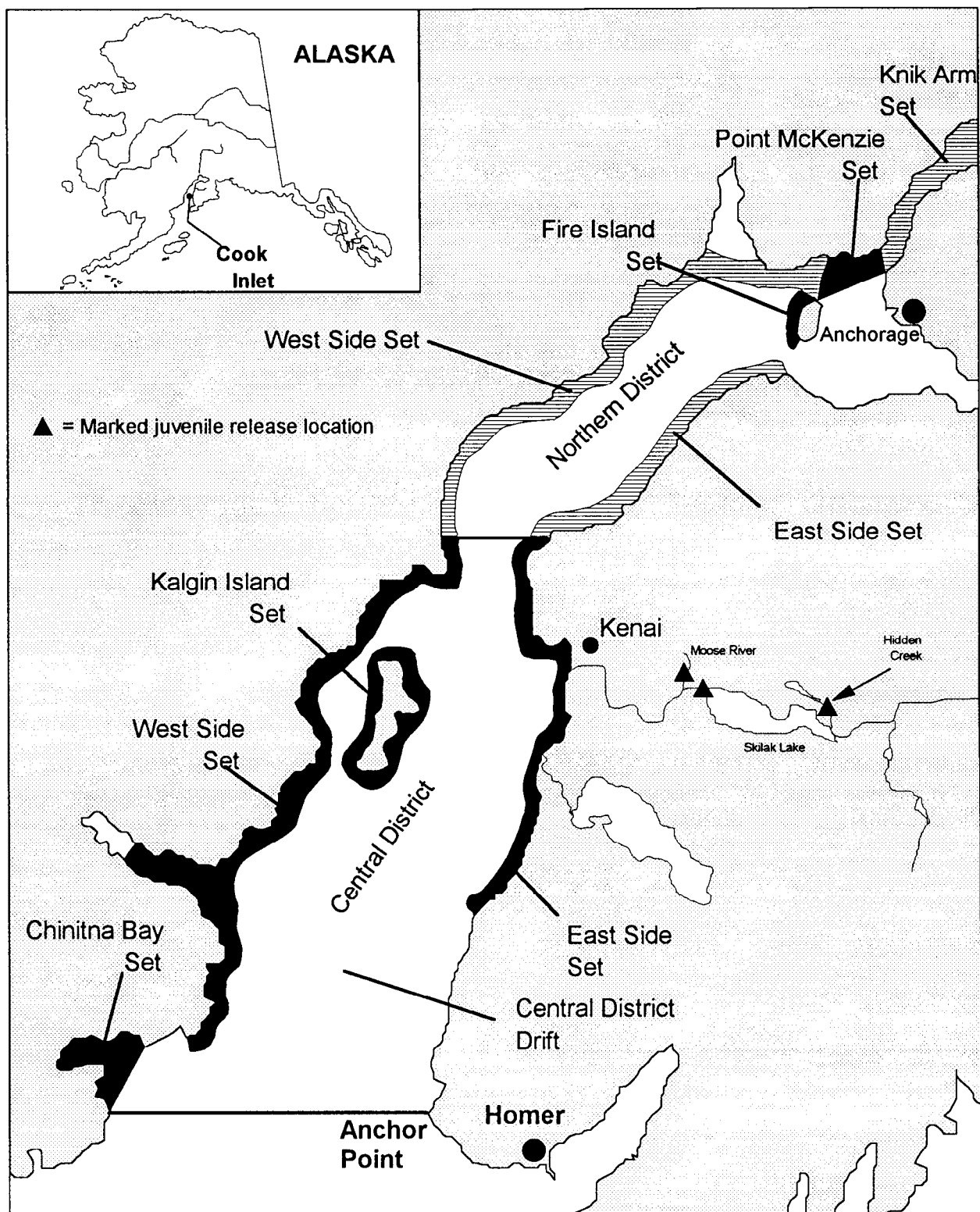


Figure 3. Schematic map of Upper Cook Inlet showing ten commercial set gill net and drift gill net fishery areas and locations at which marked coho salmon were released in the Kenai River drainage.

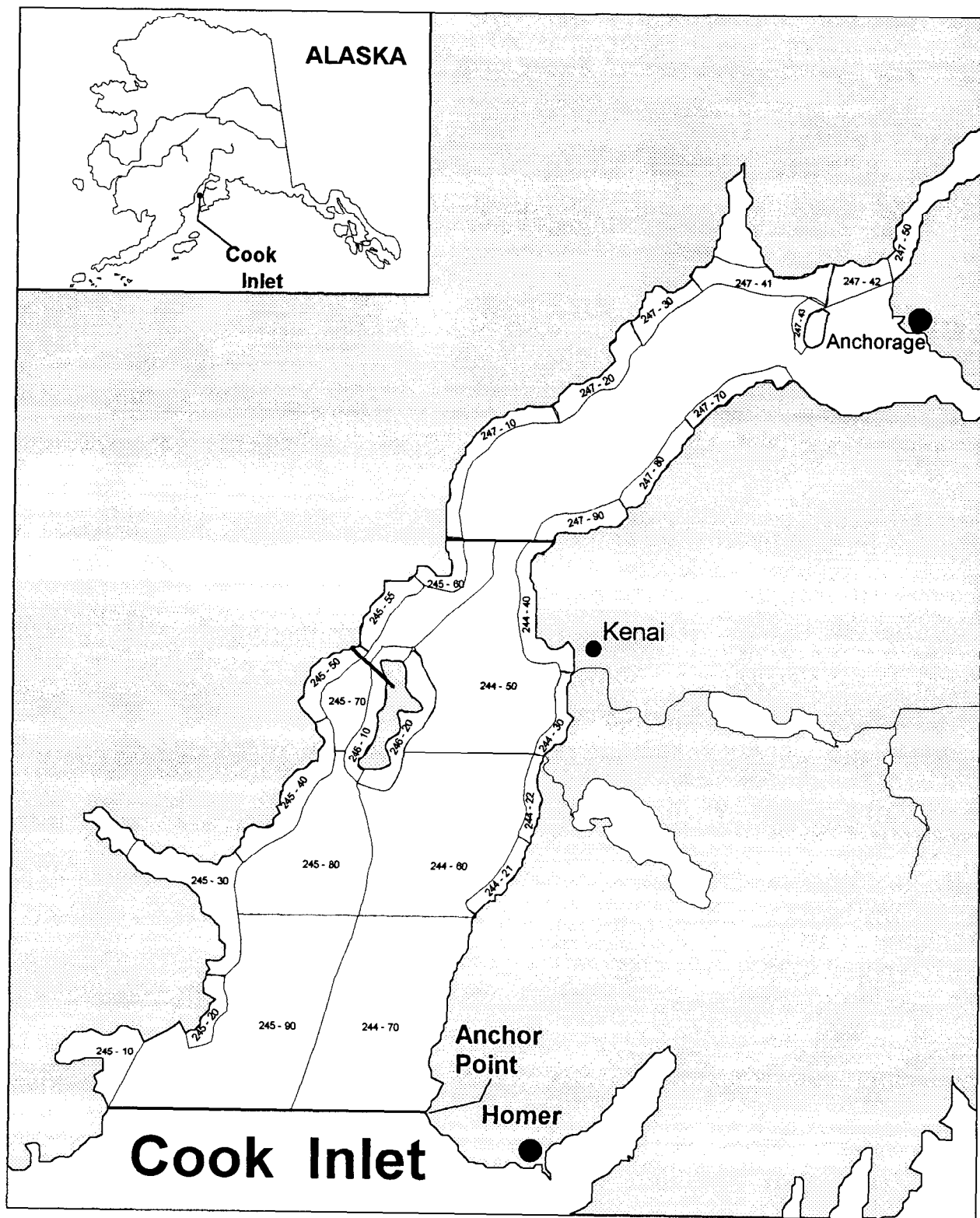


Figure 4. Schematic map of Upper Cook Inlet statistical areas.

Table 1. Releases of marked coho salmon juveniles in the Kenai River that contributed to the Upper Cook Inlet adult return in 1993.

Kenai River Release Location	Marked Fish Released ¹	Tagged Fish Released ²	Lifestage at Release	Release Dates
Moose River	74,844	73,580	Smolt	5/22 - 6/25, 1992
Hidden Creek	21,544	21,544	Smolt	5/19 - 7/01, 1992
Skilak Lake Outlet	14,395	14,329	Fingerling	8/23 - 10/31, 1991

¹ Marked fish refers to all fish released with an adipose finclip.

² Tagged fish refers to all marked fish that did not shed the embedded CWT during overnight tag retention test period.

identify each as bearing a coded wire tag. Marked fish were released to continue their seaward migration.

Adults returning to spawn in 1993 were harvested in UCI commercial fisheries. Personnel sampled a portion of the harvest at commercial processing locations and recorded the number of coho salmon examined and the number observed with a missing adipose fin. Heads were removed from adipose-clipped adults and shipped to the Alaska Department of Fish and Game Tag Lab¹ to retrieve and decode the tags. This mark and recovery "cycle" is necessary to estimate the commercial harvest in UCI of coho salmon from the Kenai River.

To estimate the commercial harvest of a marked cohort requires knowing or estimating: (1) the overall harvest in each fishery, and (2) the proportion of the cohort that was marked. The number of marks found during commercial harvest sampling can then be expanded into a contribution estimate to account for unmarked fish in the cohort and for the portion of the harvest not examined. The Commercial Fish Ticketing System managed by the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division provided the commercial harvest by date and statistical area. The proportion of the Kenai River return bearing marks was estimated by examining the inriver recreational harvest and decoding tags recovered from marked adults.

An implicit assumption of this methodology is that marked individuals represent a random sample of the cohort (Clark and Bernard 1987). This means that marked individuals must mix with unmarked individuals such that the marked proportion remains constant throughout the return of the cohort. This assumption was evaluated by examining coho salmon harvested in the Kenai River recreational fishery for marks and testing the hypothesis that the marked proportion did not change over time. Failure to reject this hypothesis indicates that marked individuals represent a random sample of the cohort. Otherwise, the marked individuals are a biased sample of the cohort and estimating the commercial harvest of the cohort is not possible.

Harvest Sampling and Mark Recovery

Recreational and commercial harvests were examined for returning marked coho salmon. The recreational harvest was examined to estimate the proportion bearing marks while the commercial harvest was examined to recover marked fish of known origin.

Recreational Fishery:

During August and September 1993, coho salmon harvested by the inriver recreational fishery were examined for a missing adipose fin. Field personnel roved throughout the fishery and at access locations to examine the harvest of anglers fishing from boats and those fishing from shore. Daily counts of total fish examined and adipose-clipped fish found were recorded. Heads collected from adipose-clipped fish were frozen and later shipped to the Tag Lab. Some anglers desired trophy mounts or entered fish in a salmon derby

¹ Recovered heads were sent to the Alaska Department of Fish and Game Coded Wire Tag Processing Laboratory, Commercial Fisheries Management and Development Division, Subport Building, Whittier Street, Juneau, Alaska 99802. Telephone: (907)465-3483.

contest; heads were not recovered in these cases. A hole was punched in the caudal fin of examined coho salmon to avoid sampling fish twice.

Only fish harvested from the lower 34 km of the mainstem Kenai River were examined. The harvest from this river section provided the best opportunity to examine a representative sample of the Kenai River return before fish could escape the recreational fishery by entering spawning tributaries. Only limited spawning occurs in tributaries flowing into this river section. In addition, the majority of the inriver harvest occurs in this river section and estimates of catch and harvest have been nearly identical (Hammarstrom 1992; Schwager-King 1993) indicating that very little selectivity occurs.

Commercial Fishery:

Samples of commercially harvested coho salmon were examined at buying stations or at main processing plants located along Cook Inlet. The harvests from three fishery areas were intensely sampled during 1993. These included the drift gill net and the eastside set gill net fisheries of the Central District and the set gill net fisheries of the Northern District. These three fisheries historically account for most of the Cook Inlet harvest (Ruesch and Fox 1994). Northern District fisheries were sampled intensely to estimate the contribution of hatchery-produced smolt that were released in selected Northern District streams. Harvests occurring in other fishery areas were sampled incidentally throughout the season.

The Central District drift gill net and eastside set gill net fisheries harvest coho salmon returning to Upper Cook Inlet between late June and mid-August, after which the set gill net fishery closes by regulation and drift gill net fishing is restricted by regulation to the west side of the Central District. Fishing effort in Northern District fisheries declines in early September when fish abundance drops to a low level. The Central District eastside set gill net harvest was examined until the fishery closed. The drift gill net and the Northern District harvests were examined until harvests declined to low levels.

Sampling personnel recorded the total number of coho salmon examined and the total number that were missing the adipose fin. Heads were collected from most adipose-clipped fish for later retrieval of the embedded coded wire tag. The following information was also recorded for examined fish: date sold (date harvested), statistical area of harvest when available, and processor. In general, the statistical area was known for set net harvests. Drift net harvests delivered to processing locations were typically a mix of fish from multiple unknown statistical areas.

Data Analysis

Data analysis included estimating the proportion of the Kenai River cohort bearing marks, estimating contribution, and summarizing the harvest and sampling efforts in commercial fisheries.

Estimating the Proportion of the Cohort Bearing Marks:

To estimate the commercial harvest of coho salmon from the Kenai River, an estimate of the proportion of the cohort marked with coded wire tags is

required. This proportion was unknown when juvenile coho salmon were marked, but was estimated during 1993 by examining the inriver recreational harvest.

A chi-square statistic was used to test the hypothesis that the proportion of tagged coho salmon recovered from the recreational harvest did not change over time. The recovery data were divided into four 2-week time intervals. Under the null hypothesis the *a priori* estimate of proportion marked equaled 0.015. Sufficient samples were collected in each interval so that a difference of 0.010 from the hypothesized value could be detected among the time intervals at $\alpha = 0.05$ and $\beta = 0.30$.

If the proportion marked remained constant over the duration of the return, the number of smolt that emigrated from the Kenai River in 1992 could be estimated. The model to estimate the smolt emigration also assumed that coho salmon were examined at random from the inriver harvest, survival and catchability were the same for marked and unmarked individuals, and that no tags were lost between the mark and recovery events. The smolt emigration was estimated using the Chapman modified Lincoln-Petersen model (Seber 1982):

$$\hat{N} = \frac{(M + 1)(C + 1)}{R + 1} - 1, \quad (1)$$

where:

- M = the number of smolt emigrating with a coded wire tag in 1992,
- C = the number of coho salmon examined in the recreational harvest for a missing adipose fin, and
- R = the number of coho salmon recovered that were marked in the Kenai River.

The variance was estimated by:

$$V(\hat{N}) = \frac{(M + 1)(C + 1)(M - R)(C - R)}{(R + 1)^2(R + 2)}. \quad (2)$$

A chi-square statistic was also used to test the hypothesis that the return timing of adults marked at the Moose River was independent of the time of tagging as smolt. This hypothesis was tested at $\alpha = 0.05$. Rejection of the null hypothesis would indicate that smolt marked early in the emigration exhibited a different adult return timing than smolt marked late in the emigration. The population marked in 1992 was divided into two categories for the test: (1) the first 50% of the smolt marked (May 25-June 3) and (2) the second 50% of the smolt marked (June 4-June 25). The two recovery distributions were compared over 2-week intervals during August and September of 1993.

Contribution Estimates:

The commercial harvest of coho salmon from the Kenai River may be estimated as the product of the total harvest of coho salmon in a fishery, intermediate statistics based on the catch sampling program of the fishery, and the estimated proportion of coho salmon from the Kenai River that were marked. The total commercial harvest was considered a known constant measured without

error. The weight of coho salmon in the commercial harvest was censused when sold to processors; fish were sold by weight and the weight by species was reported on each fish ticket issued. The weight was converted to number by dividing total weight by average weight per individual. Although the average weight was estimated, the overall variance of the number harvested was considered low because the entire harvest was weighed. Therefore, the number of coho salmon harvested was considered known, not estimated.

The estimated contribution of coho salmon from the Kenai River to the eastside set gill net fishery was stratified by date and statistical area. The contribution to the drift gill net fishery was stratified by date only because statistical area was unknown; coho salmon sampled were often a mixture of fish harvested from more than one statistical area. The contribution of the marked cohort to each fishery was estimated by summing the estimates among strata. The variance of each contribution estimate was also calculated by summing strata variances. Because strata were considered independent, there were no additional covariance terms.

To determine if the data should also be stratified by processor, marked proportions of sampled fish were tested among processors for each of the two fisheries. The null hypothesis was that the proportion of the harvest consisting of fish marked at the Moose River did not differ among processors that were sampled. Significant differences would indicate a nonrandom distribution of marked fish among processors. This would result in biased estimates of contribution if the data were pooled among processors. Chi-square statistics indicated that some differences existed among processors. However, the proportion marked was < 0.01 among processors of the drift gill net harvest and ranged between 0.01 and 0.05 for processors of the eastside set gill net harvest. These proportions were considered too small to substantially bias contribution estimates and the sample data were pooled among processors.

The harvest of the Kenai River cohort in each stratum was estimated by (Clark and Bernard 1987, Clark and Bernard *Unpublished*).

$$\hat{n}_1 = N \hat{\theta}^{-1} \left(\frac{m_1 a_1 m_c}{m_2 a_2 n_2} \right) = N \hat{\theta}^{-1} \hat{p} \quad (3)$$

where:

- N = total number of fish in the harvest,
- θ = proportion of the cohort bearing tags,
- m_1 = number of heads with tags detected,
- m_2 = number of tags found and decoded,
- a_1 = number of heads collected from fish with a missing adipose fin,
- a_2 = number of heads that arrived at the Tag Lab,
- m_c = number of tags decoded for the cohort, and
- n_2 = number of fish in the harvest examined for a missing adipose fin.

This estimator is statistically unbiased when sampling is from a simple random or pseudo-random process (Geiger 1990). An unbiased estimate of the variance is (Clark and Bernard *Unpublished*):

$$V[\hat{n}_1] = \hat{n}_1^2 [G(\hat{p}) + G(\hat{\theta}^{-1}) + G(\hat{p})G(\hat{\theta}^{-1})] \quad (4)$$

where:

$$G(\hat{p}) = \frac{1 - \lambda\phi\theta}{\lambda\phi\hat{n}_1},$$

$$\lambda = \frac{m_2 a_2}{m_1 a_1},$$

$$\phi = \frac{n_2}{N}, \text{ and}$$

$$G(\hat{\theta}^{-1}) = \frac{V(\hat{\theta}^{-1})}{\hat{\theta}^{-2}}.$$

Stratum estimates of contribution were combined into five time intervals for reporting purposes. These intervals include an early season interval of 9 days and four 7-day intervals during the peak of the fishery.

RESULTS

Estimating the Proportion of the Cohort Bearing Marks

A total of 4,626 coho salmon harvested in the inriver recreational fishery were examined at random for missing adipose fins during August and September of 1993 (Table 2). Heads were recovered from 415 of 477 adipose-clipped adults observed. Of the 415 heads processed at the Tag Lab, most were marked as smolt at the Moose River in 1992 (Figure 5). Tags were not present in 9% of the heads recovered from sampling the fishery. An additional 146 coho salmon heads were voluntarily delivered by anglers to department personnel (Appendix A1). Of these, the majority (74%) were also originally marked at the Moose River in 1992.

The proportion of adipose-clipped fish in the recreational harvest did not differ significantly ($\chi^2 = 6.12$, $df = 3$, $P = 0.11$) among 2-week intervals (Table 3). However, the distribution of recoveries varied among cohorts (Appendix A1). Almost half of the recoveries of coho salmon marked at Skilak Lake were made during the latter half of August; these fish were therefore not representative of the Kenai River return timing in 1993. There were few recoveries of the cohort marked at Hidden Creek and all occurred between August 17 and September 18. This timing was also not representative of the return of the entire Kenai River cohort.

The proportion of the Kenai River return bearing Moose River tags did not differ significantly ($\chi^2 = 6.65$, $df = 3$, $P = 0.08$) among 2-week intervals. The proportion also remained relatively constant over weekly periods except for the first period (August 1 through August 7) when it was lower than the other 7 weeks (Figure 6). The return timing of adults was independent of time of

Table 2. Sources of marked coho salmon adults recovered at random from the Kenai River recreational harvest, August through September 1993.

Period	Number Examined	Number of Marked Fish Observed	Number of Marked Fish Recovered	CWT Missing	Release Location and Year for Decodable CWT's				
					Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Homer Spit 1992 ¹	Ship Creek 1992 ¹
8/01 - 8/07	167	11	9	1	6	2			
8/08 - 8/14	452	47	42	2	36	4			
8/15 - 8/21	686	67	64	8	46	8	2		
8/22 - 8/28	937	98	95	9	77	9			
8/29 - 9/04	408	51	44	5	36	1	2		
9/05 - 9/11	600	78	61	1	56	1	2		1
9/12 - 9/18	519	48	40	6	29	4	1		
9/19 - 9/25	735	66	49	5	40	3		1	
9/26 - 9/30	122	11	11	1	10				
Grand Total	4,626	477	415	38	336	32	7	1	1

¹ These were hatchery-produced fish that were released as smolt in Cook Inlet at locations other than the Kenai River and strayed into the Kenai River as adults in 1993.

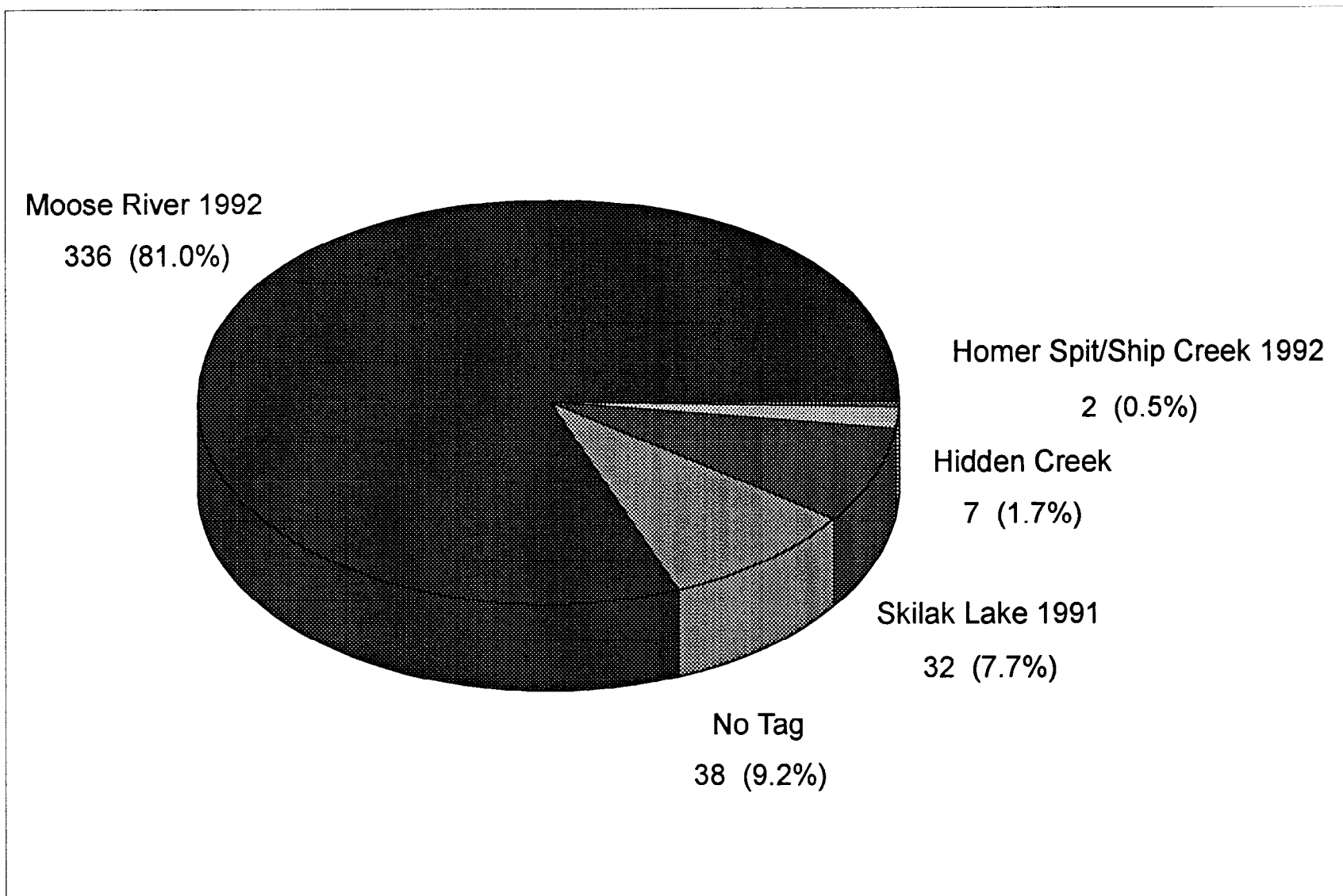


Figure 5. Sources of 415 adipose-clipped coho salmon recovered from the Kenai River recreational harvest during August and September, 1993.

Table 3. Number of coho salmon examined for adipose finclips in the Kenai River recreational fishery during August and September 1993, number of adipose-clipped fish found, and number originally marked as smolt at the Moose River in 1992.

Interval	Number Examined	Adipose-clipped Fish Found	Number Marked at Moose River
8/01 - 8/15	664	65	45
8/16 - 8/31	1,745	176	133
9/01 - 9/15	970	120	84
9/16 - 9/30	1,247	116	74
Total	4,626	477	336

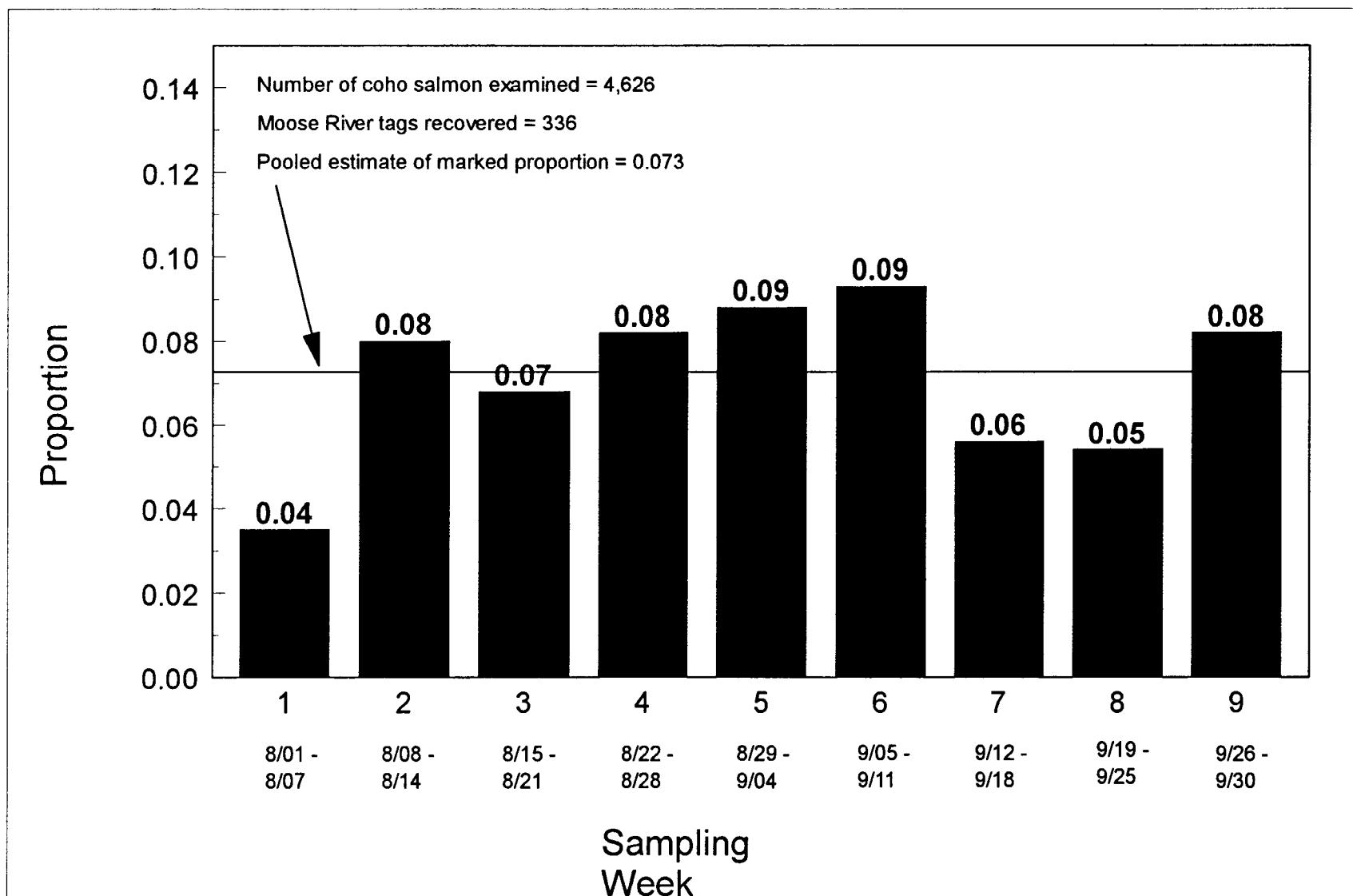


Figure 6. Proportion of the Kenai River recreational coho salmon harvest bearing Moose River coded wire tags by weekly period during 1993.

marking as smolt at the Moose River in 1992 ($\chi^2 = 2.57$, $df = 3$, $P = 0.46$; Figure 7 and Appendix A2) and all tag codes released at the Moose River were represented in the adult return. These tests indicate that the cohort marked at the Moose River was representative of the Kenai River cohort returning as adults in 1993. Based on these fish, the marked proportion of the Kenai River cohort returning in 1993 was 0.0728.

The number of smolt marked at the Moose River in 1992 was 73,780 (Carlson 1992), the number of coho salmon examined in the Kenai River recreational harvest was 4,626, and the number of Moose River tags recovered was 336. Using these values in Equation (1), the estimated number of smolt emigrating from the Kenai River in 1992 was 1,010,264 ($SE = 52,791$).

Harvest and Sampling Performance

Harvest and sampling performance are included to add perspective to contribution estimates and to provide information with which to refine future sampling efforts.

Inlet-Wide Fisheries:

A total of 306,822 coho salmon were harvested and sold to commercial processors during the 1993 UCI commercial fishing season. This harvest level was 45% less than the average of the last 10 years, and 16% less than the average since 1966 (Table 4).

Approximately two thirds of the 1993 UCI commercial harvest was taken in Central District Fisheries (Figure 8). The greatest harvest occurred in the drift gill net fishery of the Central District, followed by the set gill net fishery on the west side of the Northern District and the Central District eastside set gill net fishery. The other seven fisheries accounted for 23% of the total harvest.

Of the inlet-wide harvest of 306,822 coho salmon, 82,699 (27%) were examined for adipose-clips. The most intensely sampled fisheries were the Northern District set gill net fisheries as a group, the Central District drift gill net fishery, and the eastside set gill net fishery of the Central District (Figure 9). Of the fish examined, 2,358 (3%) adipose-clipped fish were found, and heads from all but two were recovered (Table 5 and Appendix A3). Adipose-clipped fish were found in all ten fisheries. Fifteen marked cohorts from UCI release locations were recovered as were two fish from two release locations outside of UCI (Homer Spit and Mile 25) (Figure 10). With the exception of the fish marked within the Kenai River drainage, all recoveries involved adults released as hatchery-produced smolt or fingerling. Recoveries of hatchery-produced coho salmon are summarized by Hoffmann and Hasbrouck (1994). Of the 2,356 heads recovered from adipose-clipped fish, 479 (20%) had no tag present.

A total of 214 tags released among four groups of fish in the Kenai River drainage was recovered from UCI commercial harvests in 1993 (Table 6). The cohort marked as smolt at the Moose River in 1992 comprised the majority (84%) of the marks recovered, followed by the cohort marked at the outlet of Skilak Lake as fingerling in 1991 (12%). Eight fish marked as smolt at Hidden Creek in 1992 were recovered as was one fish marked at the outlet of Skilak Lake in

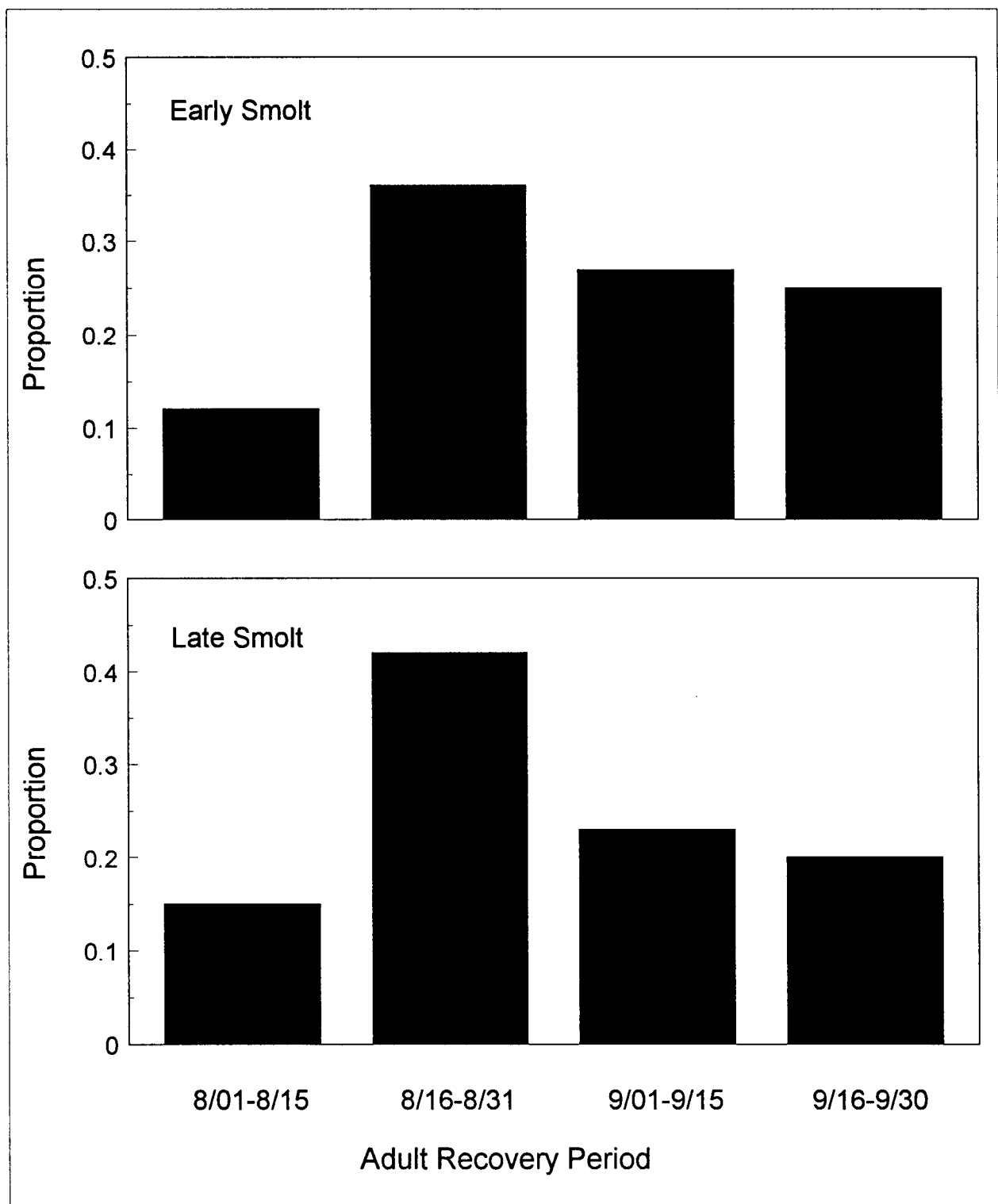


Figure 7. Proportion of "early" and "late" smolt groups recovered as adults in the Kenai River recreational harvest by 2-week intervals, 1993.

Table 4. Commercial harvest of coho salmon in Upper Cook Inlet, 1966-1992.

Year	Central District Drift Net	East Side Set Net	Kalgin Is/ West Side Set Net	Northern District Set Net	Total
1966	80,901	68,877	59,509	80,550	289,837
1967	53,071	40,738	40,066	43,854	177,729
1968	167,383	80,828	63,301	156,648	468,160
1969	33,053	18,988	28,231	20,425	100,697
1970	114,070	30,114	52,299	82,722	279,205
1971	35,491	16,589	26,188	22,094	100,362
1972	21,577	24,673	15,300	19,346	80,896
1973	31,784	23,901	24,784	23,951	104,420
1974	75,640	36,837	40,610	47,038	200,125
1975	88,579	46,209	53,537	33,051	221,376
1976	80,712	47,873	42,243	37,835	208,663
1977	110,184	23,693	38,093	20,623	192,593
1978	76,259	34,134	61,711	47,089	219,193
1979	114,496	29,284	68,306	53,078	265,164
1980	89,510	40,281	51,527	90,098	271,416
1981	226,366	36,024	88,390	134,625	485,405
1982	416,274	108,393	182,205	85,352	792,224
1983	326,965	37,694	97,796	53,867	516,322
1984	213,423	37,166	84,618	114,786	449,993
1985	357,388	70,657	147,331	91,837	667,213
1986	506,405	76,385	85,932	88,108	756,830
1987	202,306	74,977	74,930	98,920	451,133
1988	277,703	55,419	77,058	149,742	559,922
1989	743	81,744	81,004	175,710	339,201
1990	247,453	40,351	73,429	139,401	500,634
1991	175,504	30,435	87,515	132,270	425,724
1992	267,300	57,078	53,400	91,133	468,911
1982-1992 Mean ¹	299,072	58,856	96,421	104,542	558,891
1966-1992 Mean ¹	173,922	47,071	66,796	78,825	366,614
1993	121,785	43,075	35,704	106,258	306,822

¹ Harvests occurring in 1989 are excluded from the mean because of restricted fishing periods associated with the *Exxon Valdez* oil spill.

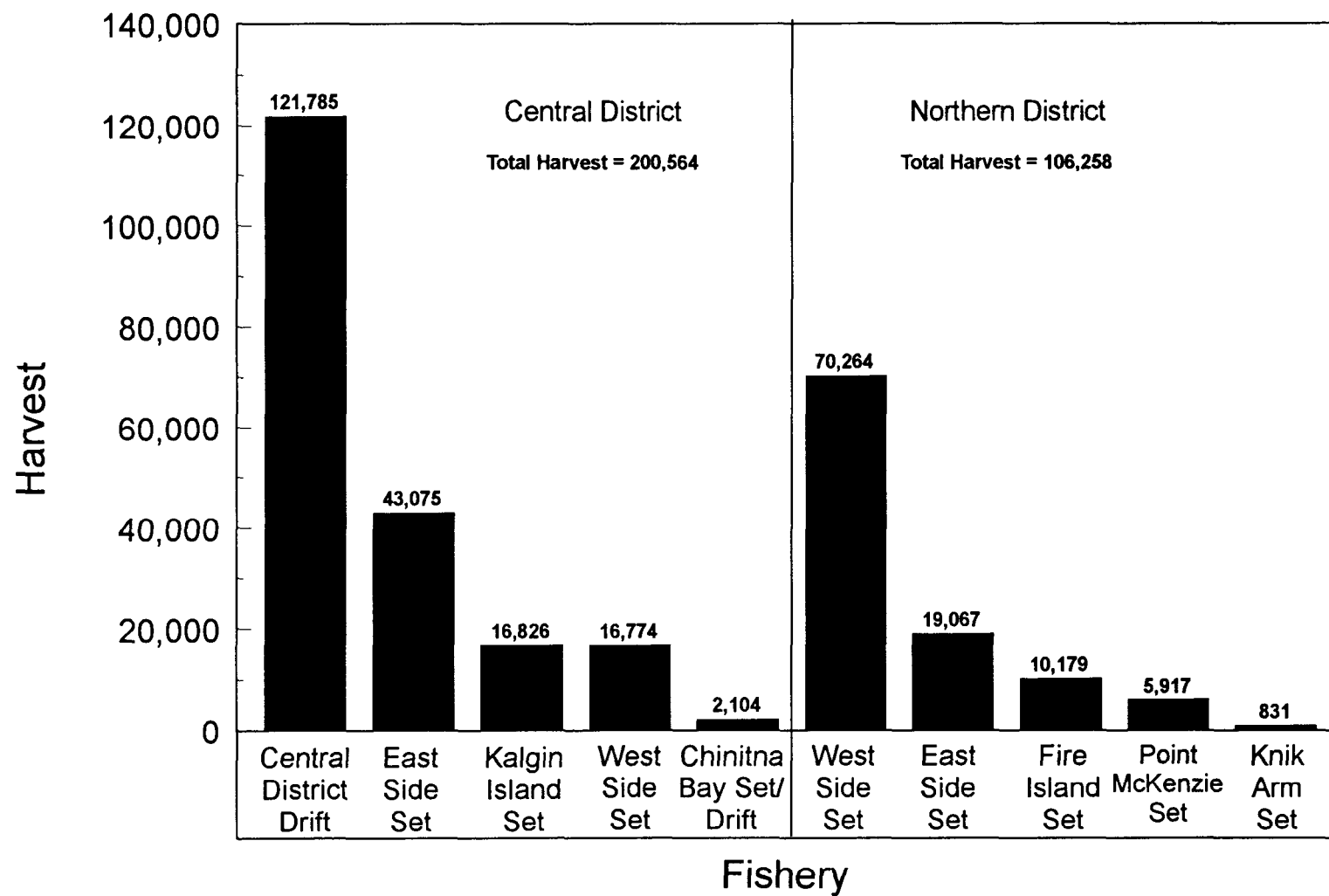


Figure 8. Coho salmon harvest in ten Upper Cook Inlet commercial fishery areas in 1993.

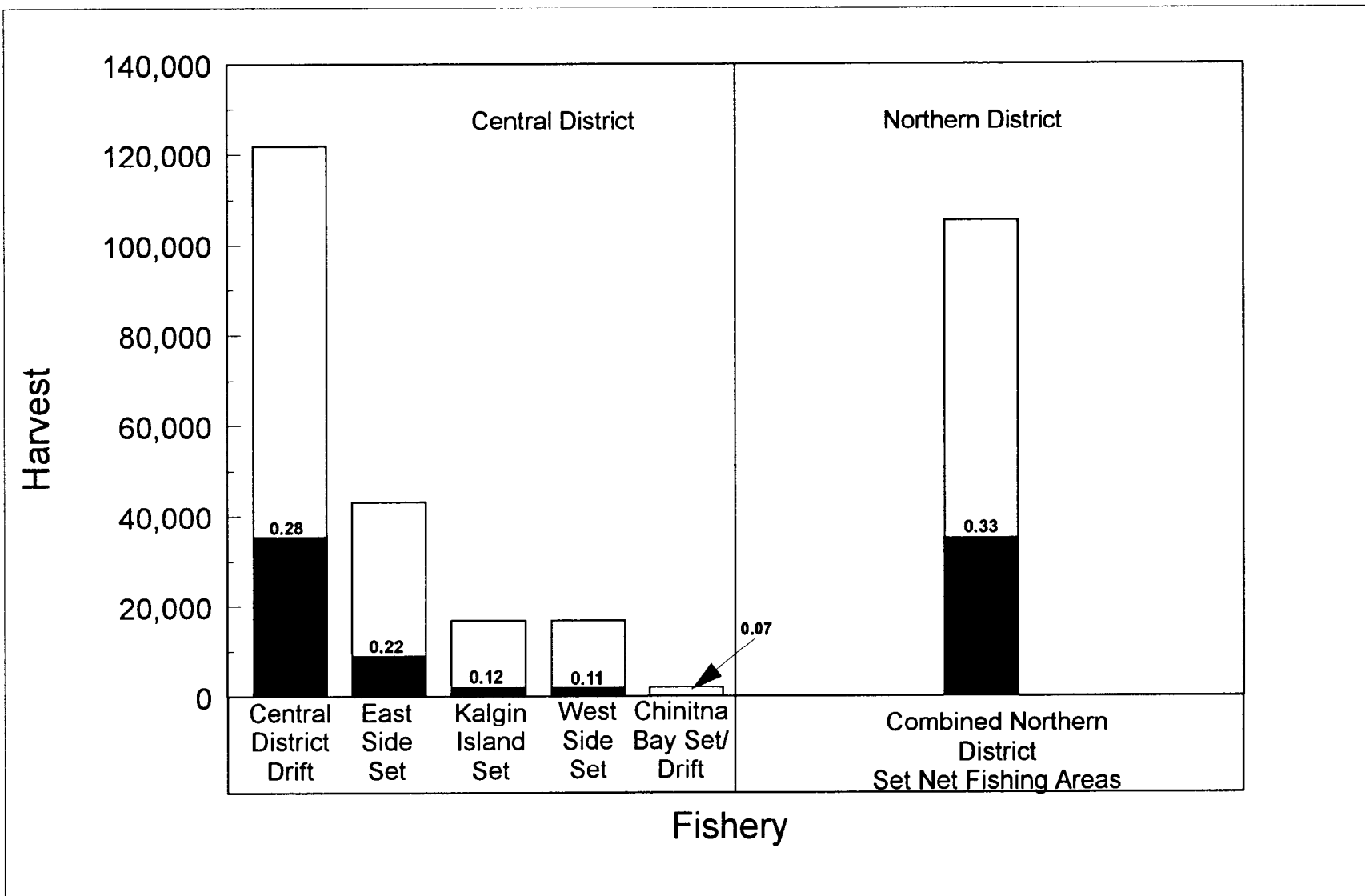


Figure 9. Proportion of the Upper Cook Inlet coho salmon commercial harvest examined for marked fish in 1993 by fishery.

Table 5. Summary of sampling effort and recovery of adipose-clipped coho salmon from Upper Cook Inlet commercial fisheries in 1993.

District	Fishery	Harvest	Number Examined	Percent of Harvest	Ad-clips Found	Heads Recovered	Heads without Tag	Heads with Decodable Tag
Central District	Drift	121,785	34,357	28	770	769	166	603
	East Side Set Net	43,075	9,469	22	384	384	59	325
	Kalgin Is. Set Net	16,826	1,958	12	35	35	9	26
	West Side Set Net	16,774	1,868	11	6	6	2	4
	Chinitna Bay Set/Drift	2,104	148	7	1	1	1	0
	Central District Total	200,564	47,800	24	1,196	1,195	237	958
Northern District	West Side Set	70,264	11,980	17	247	247	60	187
	East Side Set	19,067	12,465	65	292	292	64	228
	Fire Is. Set	10,179	6,725	66	429	429	81	348
	Pt. McKenzie Set	5,917	3,618	61	188	187	36	151 ¹
	Knik Arm Set	831	38	5	1	1	0	1
	Northern District Total	106,258	34,826	33	1,157	1,156	241	915 ¹
Unknown Area	Unknown	N/A	73	N/A	5	5	1	4
	Grand Total	306,822	82,699	27	2,358	2,356	479	1,877 ¹

¹ One recovered tag was lost at the Tag Lab before it was decoded leaving a total of 1,876 tags for decoding.

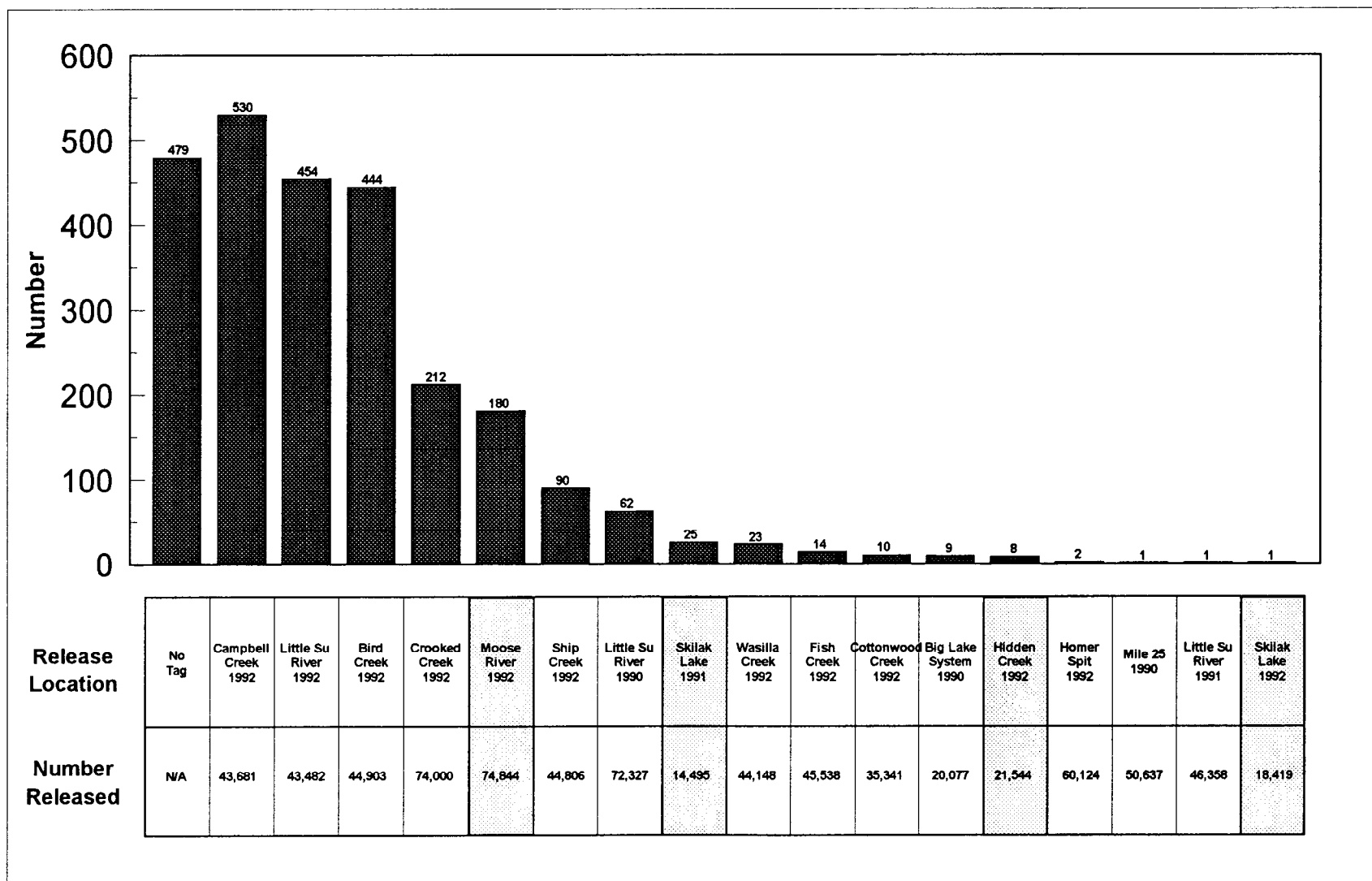


Figure 10. Sources of adipose-clipped coho salmon recovered from Upper Cook Inlet commercial fisheries in 1993. Kenai River release groups are shaded.

Table 6. Distribution of marked coho salmon of Kenai River origin from ten commercial fisheries of Upper Cook Inlet, 1993.

District	Fishery	Marked Cohort				Total Kenai River Marks Recovered
		Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Skilak Lake 1992	
Central	Drift Net	23		2		25
	East Side Set Net	146	25	5	1	177
	Kalgin Is. Set Net	2				2
	West Side Set Net					0
	Chinitna Bay Set Net					0
	Central District Total	171	25	7	1	204
Northern	West Side Set Net	2				2
	East Side Set Net	7		1		8
	Fire Is. Set Net					0
	Point McKenzie Set Net					0
	Knik Arm Set Net					0
	Northern District Total	9		1		10

1992. Most of the 214 marks (95%) were recovered from Central District fisheries and 10 (5%) were recovered from all Northern District fisheries.

Based on the distribution of recoveries among fisheries, contribution estimates were made only for the Central District drift gill net and eastside set gill net fisheries. The number of fish marked as smolt at the Moose River and recovered from other fisheries was low. Few were recovered through directed sampling of Northern District fisheries and the other seven fisheries were sampled only incidentally.

Central District Drift Gill Net Fishery:

In 1993, the district-wide season opened by regulation on June 25. After the fishing period on August 13, the area open to fishing was restricted by regulation to the western side of the Central District. The season closed by regulation on December 31, but fishing effort actually ended in early September when there were few coho available. A complete summary of time-area openings is available in a Commercial Fishery Management and Development Division annual report (Ruesch and Fox 1994).

Harvest samples were examined for marked coho salmon during most openings between July 12 and August 9, the period during which 95% (117,924 coho salmon) of the Central District total harvest of 121,785 coho salmon occurred (Figure 11). The harvest that occurred in the restricted area after August 13 was also examined, but only one adipose-clipped coho salmon was recovered and that fish had no tag present. The contribution estimate was therefore calculated for the period July 12 through August 9.

Fishery openings and harvest occurred on 25 days between July 12 and August 9 (Table 7). Daily harvests ranged between 45 and 27,144 during this period. The harvest was examined on 21 days and the proportion examined ranged from 0.13 to 0.50. Adipose-clipped fish were recovered on all but one of the days. A total of 23 coho salmon marked as smolt at the Moose River was recovered during 6 days between July 23 and August 2. The daily proportion of sampled coho salmon marked at the Moose River ranged between 0 and 0.0019 (Figure 12).

Central District Eastside Set Gill Net Fishery:

In 1993, the eastside set gill net season opened by regulation on June 28 and closed on August 13. Harvest samples were examined for marked coho salmon during most openings from July 23 through August 13, the period during which 91% (39,333 coho salmon) of the total harvest (43,075 coho salmon) occurred (Figure 13). The contribution estimate was calculated for this sampled period.

Coho salmon were harvested in all four statistical areas of the fishery. During the sampled period, the greatest portion of the harvest (48%) occurred in area 244-40 followed by 244-30 (31%), 244-22 (12%), and 244-21 (9%) (Figure 14). Over 25% of the harvest that occurred in 244-40 was examined, while a lesser proportion of the harvest from the other areas was sampled.

Fishery openings occurred on 16 days between July 23 and August 13 (Table 8). Daily harvests ranged between 868 and 4,699 during this period. Harvest samples were examined on 14 days and the proportion examined ranged from 0.11

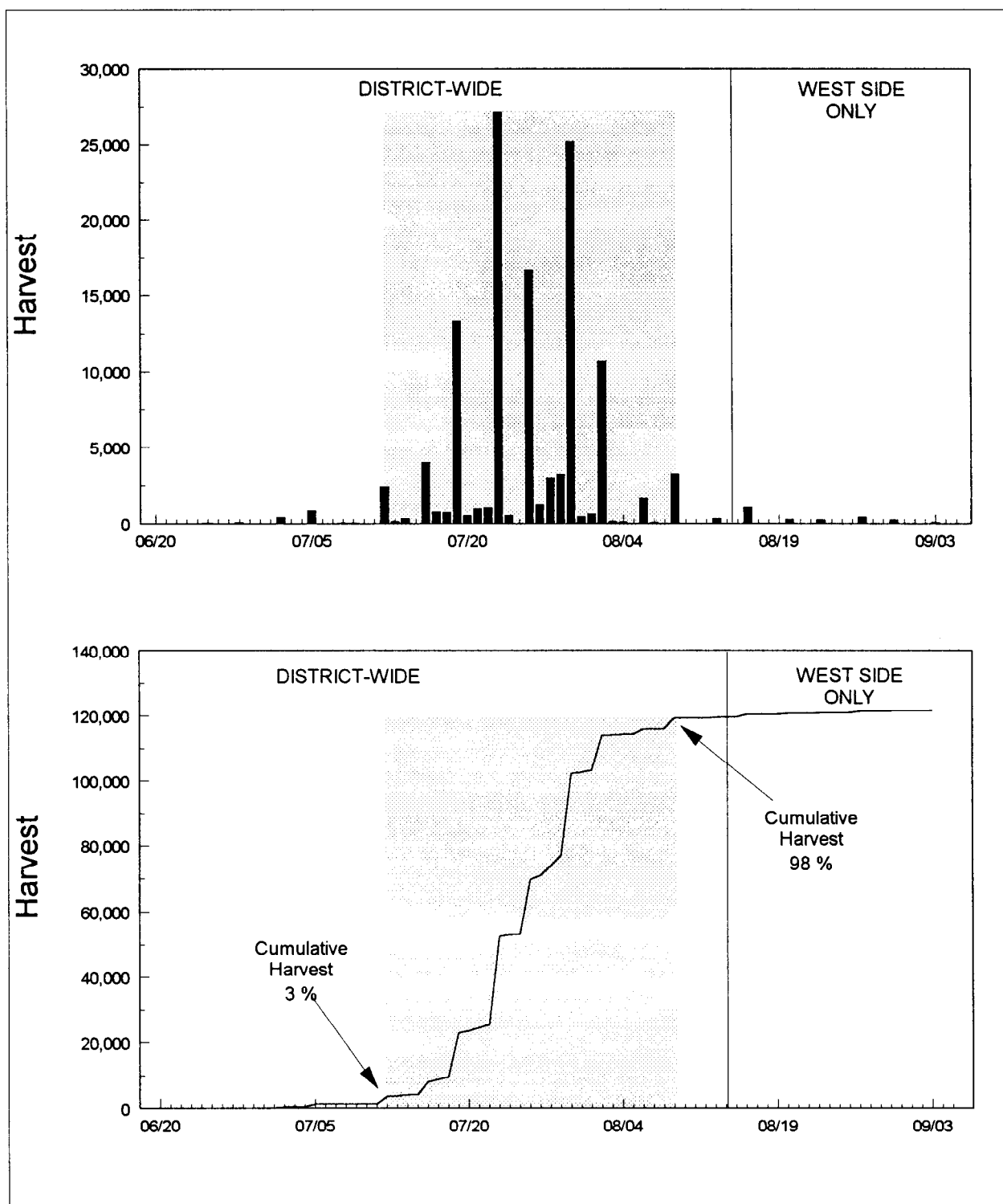


Figure 11. Daily and cumulative coho salmon harvest occurring in the Upper Cook Inlet Central District drift gill net fishery in 1993. Shaded region represents the period during which the harvest was examined and for which the contribution was estimated.

Table 7. Daily harvest, proportion of harvest examined, and recoveries of adipose-clipped coho salmon from the Central District drift gill net fishery of Upper Cook Inlet, 1993.

Fishery Opening Date	Harvest	Number Examined	Proportion Examined	Ad-clips Found	Sources of Ad-clipped Fish		
					Moose River 1992	No Tag	Other Sources
6/25	13						
6/28	73						
7/02	384						
7/05	820						
7/08	3						
7/09	7						
7/12	2,402	795	0.33	8	0	5	3
7/13	107	29	0.27	1	0	1	0
7/14	322	161	0.50	4	0	3	1
7/16 ¹	3,976	1,495	0.38	23	0	9	13
7/17	760	256	0.34	3	0	1	2
7/18	718	177	0.25	5	0	1	4
7/19	13,310	4,191	0.31	49	0	13	36
7/20	539	218	0.40	1	0	0	1
7/21	985	428	0.43	13	0	4	9
7/22	1,035	322	0.31	3	0	3	0
7/23	27,144	6,233	0.23	124	2	24	98
7/24	516						
7/26	16,659	4,691	0.28	107	1	22	84
7/27	1,238	401	0.32	15	0	4	11
7/28	2,956	993	0.34	29	1	3	25
7/29	3,200	1,099	0.34	42	2	10	30
7/30	25,177	7,938	0.32	234	11	39	184
7/31	461						
8/01	630						
8/02	10,682	3,252	0.30	90	6	20	64
8/03	135	59	0.44	0	0	0	0
8/04	94	13	0.14	1	0	0	1
8/06	1,638	206	0.13	2	0	0	2
8/07	45						
8/09	3,195	655	0.21	15	0	3	12
8/13	319						
8/16	1,063						
8/20	252						
8/23	215						
8/27	417						
8/30	243						
9/03	52						
7/12-8/09	117,924	33,612	0.29	769	23	165	580
Total	121,785	33,612	0.28	769	23	165	580

¹ One of the 23 adipose-clipped fish found on 7/16 was not recovered.

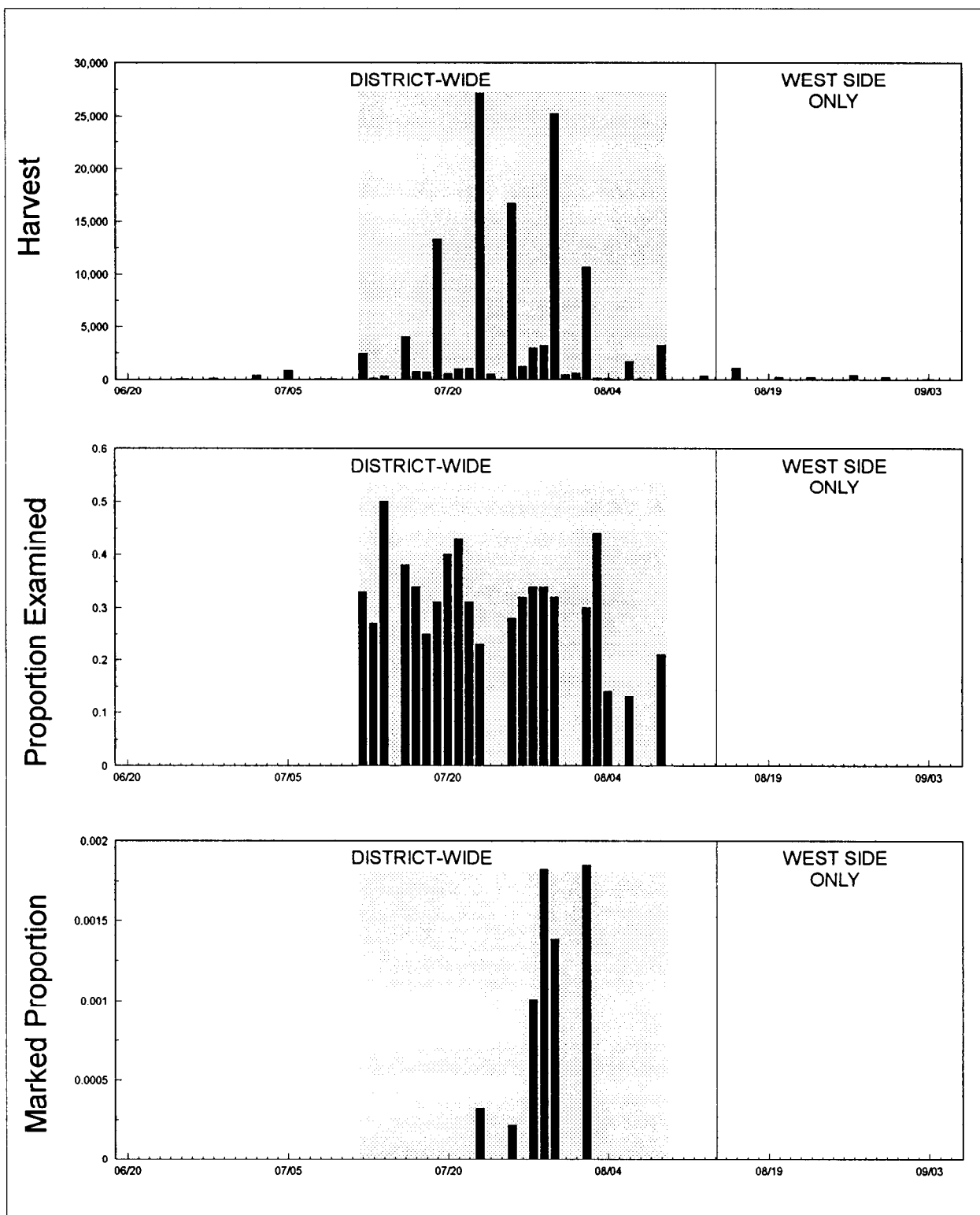


Figure 12. Daily coho salmon harvest, proportion of harvest examined, and the proportion bearing Moose River tags in the Upper Cook Inlet Central District drift gill net fishery, 1993. Shaded region represents the period during which the harvest was examined and for which the contribution was estimated.

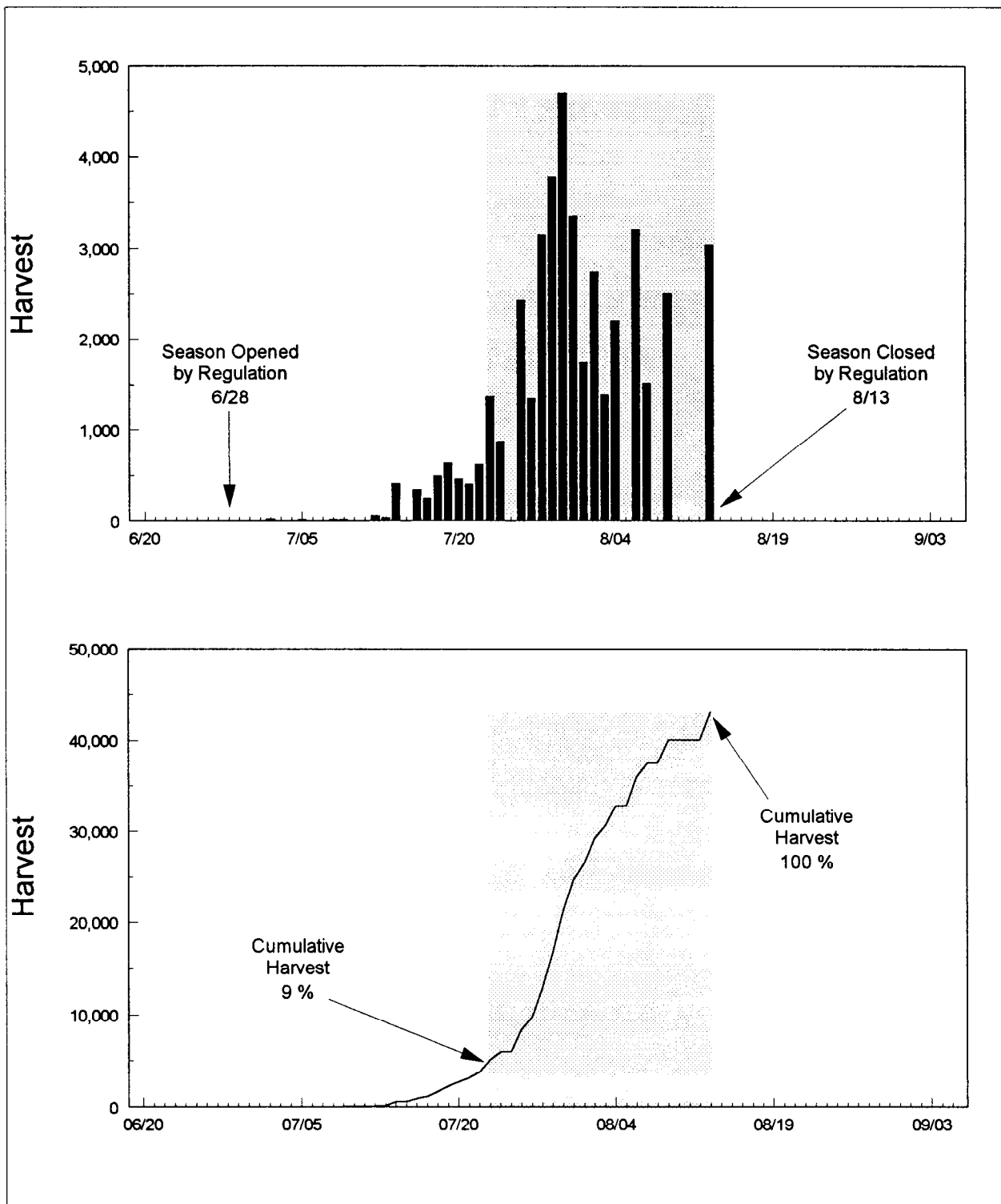


Figure 13. Daily and cumulative coho salmon harvest occurring in the Upper Cook Inlet Central District eastside set gill net fishery in 1993. Shaded region represents the period during which the harvest was examined and for which the contribution was estimated.

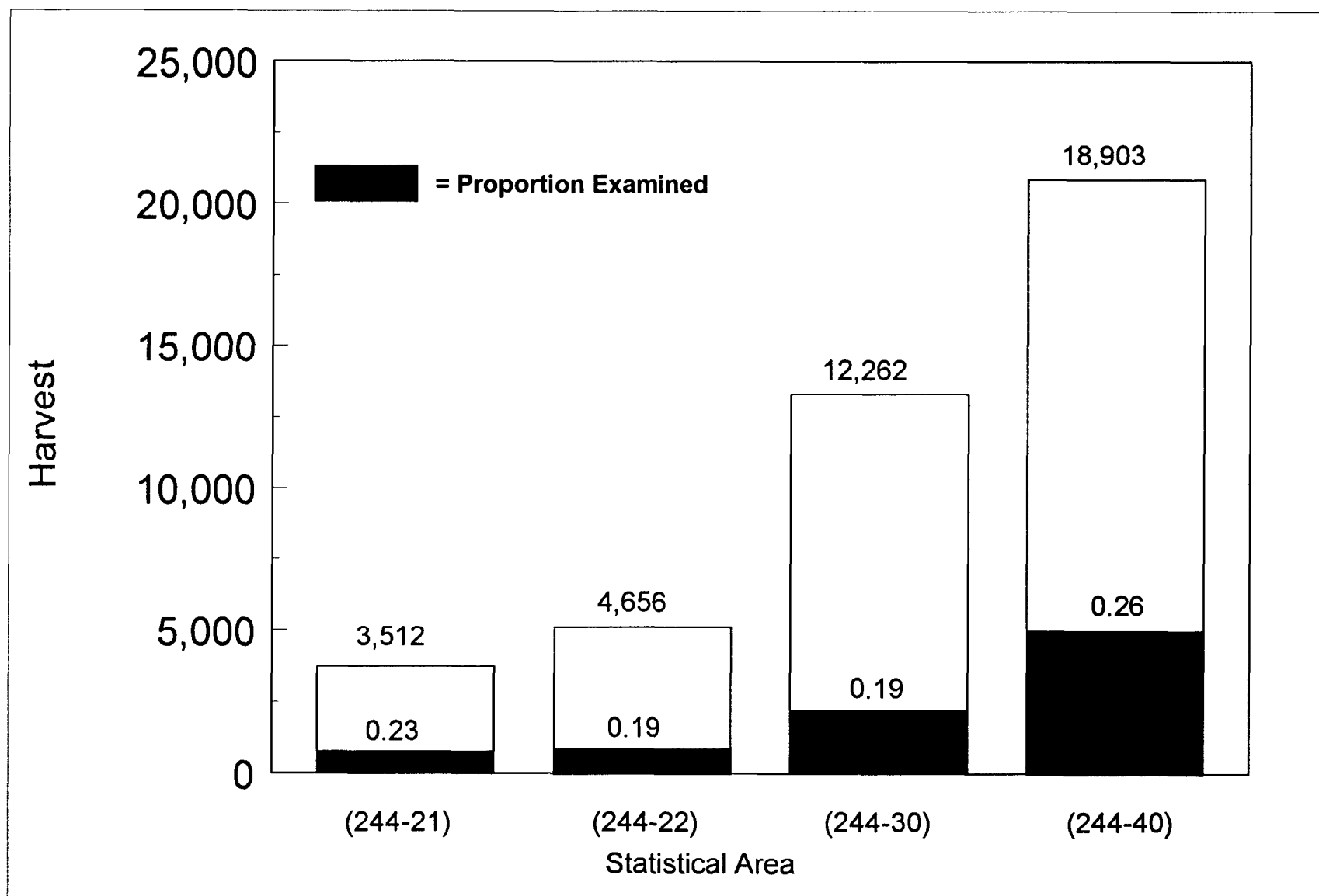


Figure 14. Proportion of the eastside set gill net harvest of coho salmon examined by statistical area during the period sampled, 1993.

Table 8. Daily harvest, proportion of harvest examined, and recoveries of adipose-clipped coho salmon from the Central District eastside set gill net fishery of Upper Cook Inlet, 1993.

Date	Harvest	Number Examined	Proportion Examined	Ad-clips Found	Sources of Ad-clipped Fish		
					Moose River 1992	No Tag	Other Sources
6/28	0						
7/02	17						
7/05	14						
7/08	10						
7/09	14						
7/12	59						
7/13	33						
7/14	408						
7/16	341						
7/17	241						
7/18	496						
7/19	632						
7/20	460						
7/21	402						
7/22	615						
7/23	1,365	156	0.11	1	1	0	0
7/24	868						
7/26	2,423	604	0.25	9	2	1	6
7/27	1,348	203	0.15	5	1	1	3
7/28	3,155	1215	0.39	31	4	6	21
7/29	3,782	688	0.18	15	0	5	10
7/30	4,699	921	0.20	34	8	5	21
7/31	3,349						
8/01	1,748	300	0.17	12	2	4	6
8/02	2,745	787	0.29	33	14	5	14
8/03	1,392	810	0.58	36	8	9	19
8/04	2,199	876	0.40	48	22	6	20
8/06	3,209	1213	0.38	66	27	8	31
8/07	1,520	427	0.28	21	11	2	8
8/09	2,498	620	0.25	32	21	2	9
8/13	3,033	649	0.21	41	25	5	11
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7/23-8/13	39,333	9,469	0.24	384	146	59	179
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Total	43,075	9,469	0.22	384	146	59	179

to 0.58. Adipose-clipped fish were recovered on all sampled days and coho salmon marked as smolt at the Moose River were recovered on all but one of the days. In all, 146 coho salmon marked at the Moose River were recovered from 9,469 fish examined. The daily proportion of examined fish marked at the Moose River ranged between 0 and 0.038 (Figure 15).

Daily coho salmon harvest, proportion examined, and the proportion of examined fish bearing Moose River marks are summarized by statistical area in Figure 16 and Appendix A4. A total of 549 examined fish, 10 of which were of Moose River origin, were recovered from unknown statistical areas. These observations were excluded from calculations of contribution to the eastside set gill net fishery. The contribution estimates are therefore based on the recovery of 136 coho salmon marked at the Moose River. The highest marked proportions occurred in the southern two statistical areas (244-21 and 244-22) and the lowest marked proportions occurred in the northern-most area (244-40).

Contribution Estimates

Estimates of the contribution of Kenai River coho salmon stocks to the drift gill net and eastside set gill net fisheries of 1993 were based on the recovery of fish marked as smolt at the Moose River in 1992. Contribution estimates were made over sampled periods during which most of the harvest occurred in each fishery. Estimates were stratified by date in both fisheries; pooling data by week did not generally improve precision. Estimates were further stratified by statistical area for the eastside set net fishery; pooling data among statistical areas likewise did not improve precision. Daily estimates and associated variances were combined over selected time intervals solely for reporting purposes and to document trends.

An estimated 7,512 coho salmon from the Kenai River were harvested in the drift and eastside set gill net fisheries of the Central District during the time intervals sampled in 1993 (Table 9). Most of the fish (86%) were harvested in the eastside set gill net fishery. The contribution of coho salmon from the Kenai River to each fishery was low relative to the total harvest occurring during sampled periods (Table 10 and Figure 17).

An estimated 1,040 coho salmon from the Kenai River were harvested by the drift fishery over an 11-day period. Too few tags were recovered to detect any trend in harvest of these fish over time. However, there was an increasing trend in the proportional contribution of Kenai River coho salmon to all statistical areas of the eastside set net fishery (Figure 18), i.e., coho salmon from the Kenai River comprised a higher proportion of the harvest later in the season. The proportional contribution to the harvest was greatest late in the season in the southernmost two statistical areas. During the last open period, nearly two-thirds of the harvest in statistical area 244-21 was comprised of coho salmon from the Kenai River while nearly half of the harvest that occurred in statistical area 244-22 was comprised of Kenai River coho salmon. During the sampled period, there was an increasing trend in proportional contribution and a decreasing trend in total harvest from the northern-most statistical area to the southernmost (Figure 19).

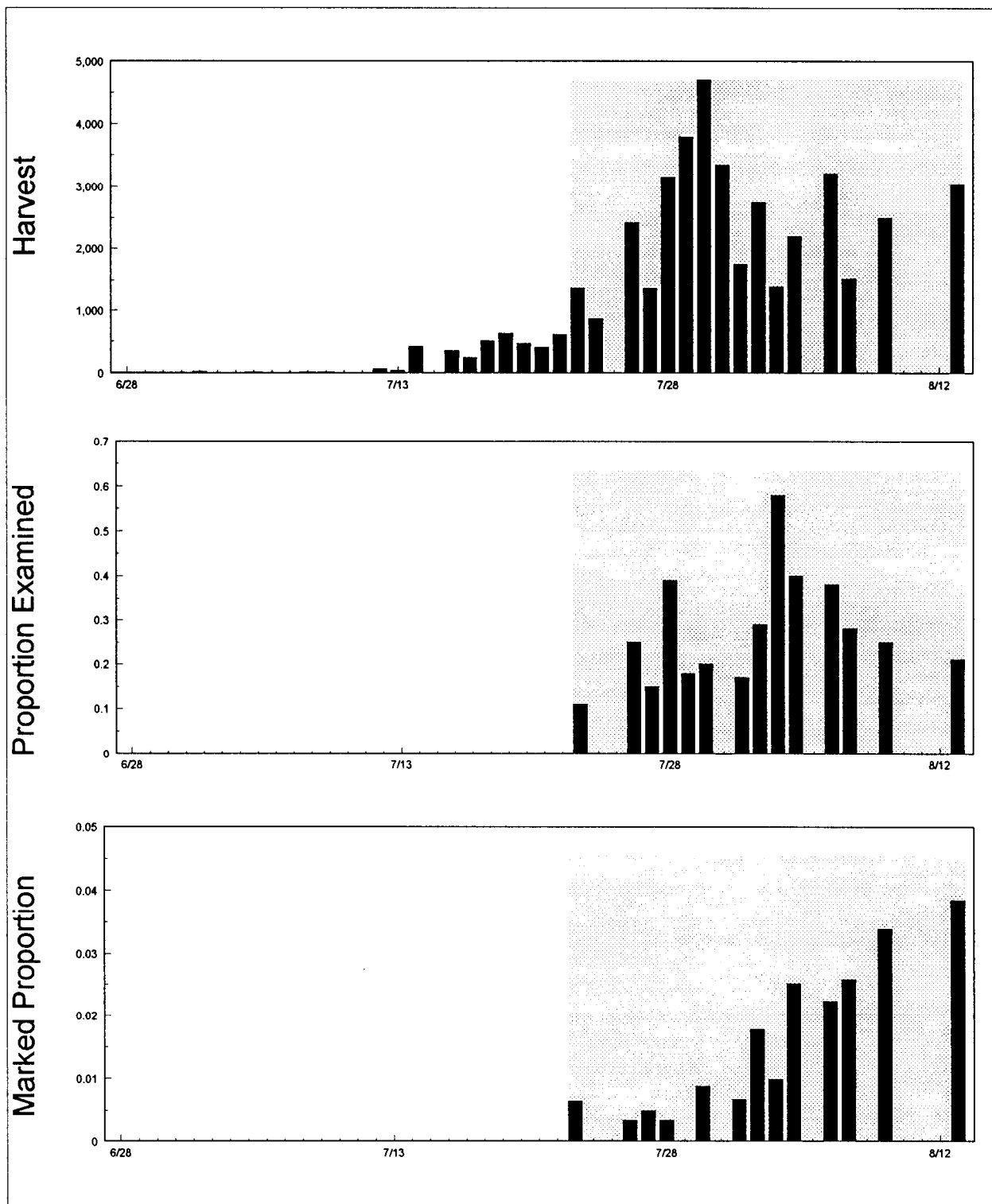


Figure 15. Daily coho salmon harvest, proportion of harvest examined, and the proportion bearing Moose River tags in the Upper Cook Inlet Central District eastside set gill net fishery, 1993. Shaded region represents the period during which the harvest was examined and for which the contribution was estimated.

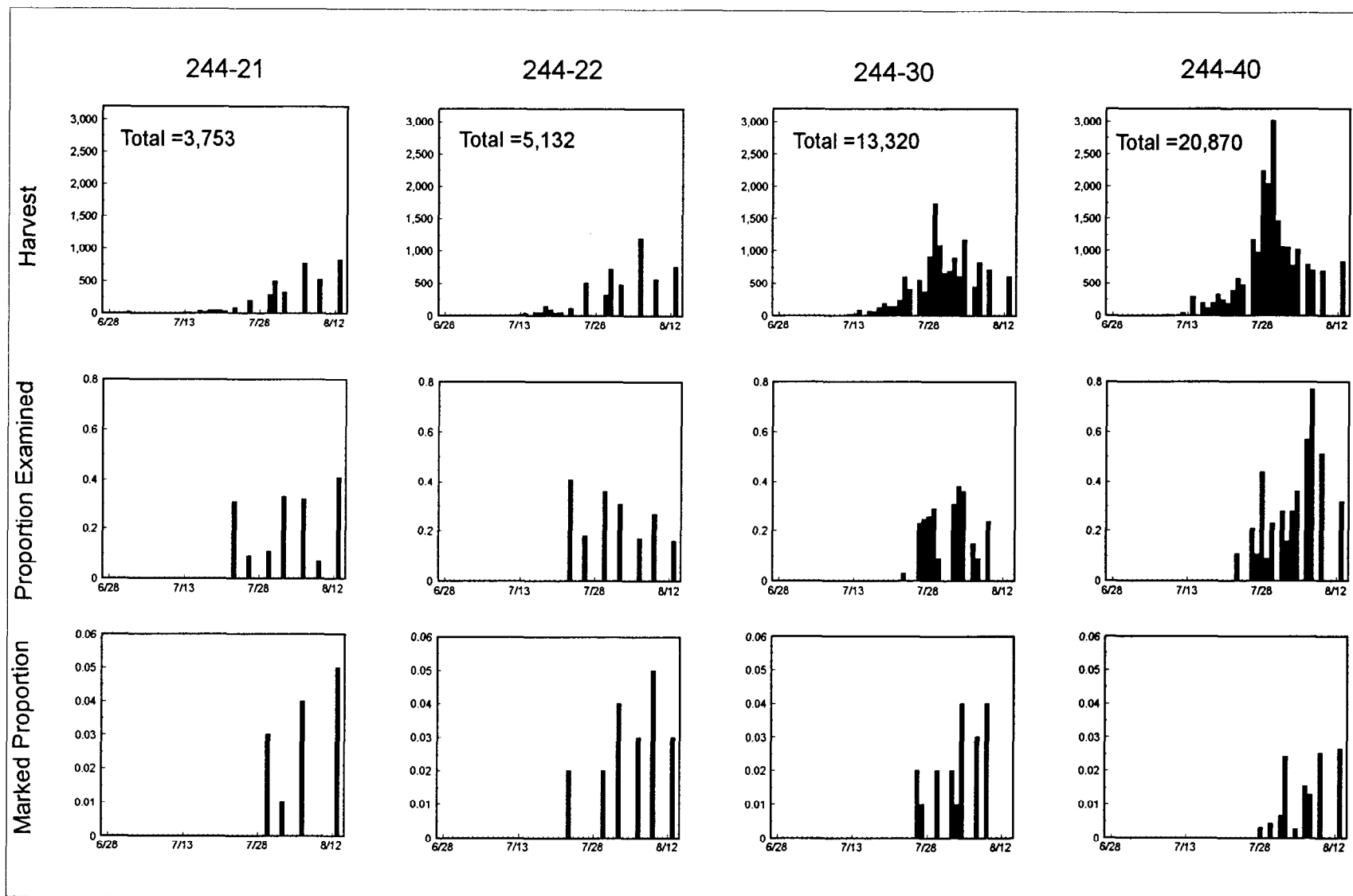


Figure 16. Daily coho salmon harvest, proportion of harvest examined, and the proportion bearing Moose River tags in the Upper Cook Inlet Central District eastside set gill net fishery, 1993.

Table 9. Estimates of contribution (n1) with variance [V(n1)] of Kenai River coho salmon to the drift gill net and eastside set gill net fisheries of Upper Cook Inlet, 1993.

Fishery	Statistical Area	7/22-7/28		7/29-8/04		8/05-8/11		8/12-8/13		Total		Relative Precision
		n(1)	V(1)	n(1)	V(1)	n(1)	V(1)	n(1)	V(1)	n(1)	V(1)	
Drift Net ¹	244 & 245	210	11,118	830	36,428	0		0		1,040	47,546	0.41
East Side	244-21			171	18,298	428	18,455	538	18,423	1,137	55,176	0.41
Set Net	244-22	33	1,067	344	14,759	912	63,235	345	29,796	1,634	108,857	0.40
	244-30	225	12,572	1,270	89,963	669	71,683	0		2,164	174,218	0.38
	244-40	95	2,937	525	23,087	638	18,388	279	19,456	1,537	63,868	0.32
	Total	353	16,576	2,310	146,107	2,647	171,761	1,162	67,675	6,472	402,119	0.19
Combined		563	27,694	3,140	182,535	2,647	171,761	1,162	67,675	7,512	449,665	0.17

¹ The drift net harvest was first examined on 7/12, but Moose River coho salmon were not recovered until 7/23.

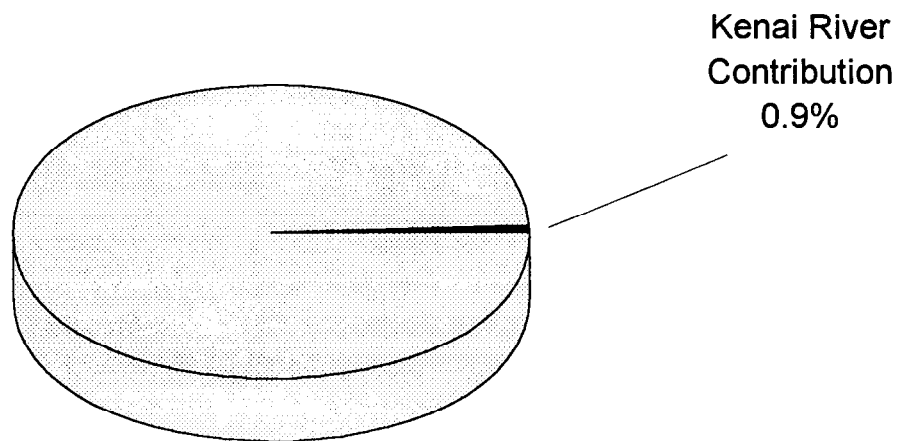
Table 10. Harvest and estimated contribution of Kenai River coho salmon to the drift gill net and eastside set gill net fisheries of the Central District of Upper Cook Inlet during selected time intervals, 1993.

												Total Shaded ¹
Statistical			Dates		Time Interval							
Fishery	Areas		Begin	End	6/25-7/11	7/12-7/21	7/22-7/28	7/29-8/04	8/05-8/11	8/12-8/18	8/19-9/03	Area
Drift	244 & 245	Total Harvest	6/25	9/03	1,300	23,119	49,548	40,379	4,878	1,382	1,179	117,924
		Contribution	7/12	8/09		0	210	830				1,040
East Side	244-21	Total Harvest	7/02	8/13	23	218	270	1,109	1,305	828		3,512
Set Net		Contribution	7/23	8/13			0	171	428	538		1,137
	244-22	Total Harvest	7/02	8/13	11	465	620	1,512	1,765	759		4,656
		Contribution	7/23	8/13			33	344	912	345		1,634
	244-30	Total Harvest	7/05	8/13	9	816	3,063	6,857	1,967	608		12,262 ²
		Contribution	7/23	8/13			225	1,270	669			2,164
	244-40	Total Harvest	7/05	8/13	12	1,573	5,821	10,436	2,190	838		18,903 ²
		Contribution	7/23	8/13			95	525	638	279		1,537
	Combined Set Net	Total Harvest	7/02	8/13	55	3,072	9,774	19,914	7,227	2,425		39,333
		Contribution	7/23	8/13			353	2,310	2,647	1,162		6,472

¹ Shaded areas represent time intervals during which the harvest was examined and contribution estimates were calculated.

² Totals are adjusted to account for one day not sampled during the period 7/22-7/28.

Central District Drift Net Harvest



Central District East Side Set Net Harvest

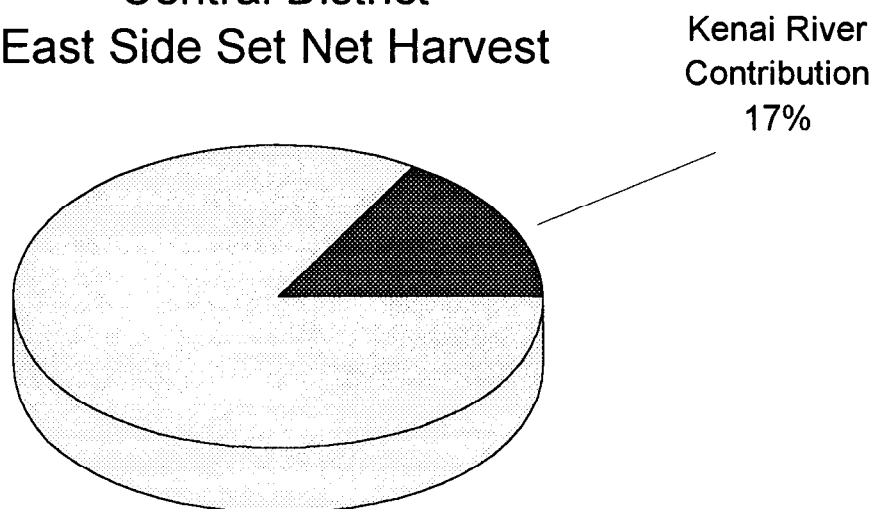


Figure 17. Contribution of Kenai River coho salmon to the 1993 drift gill net and eastside set gill net harvests in the Central District of Upper Cook Inlet during the period when the harvest was examined.

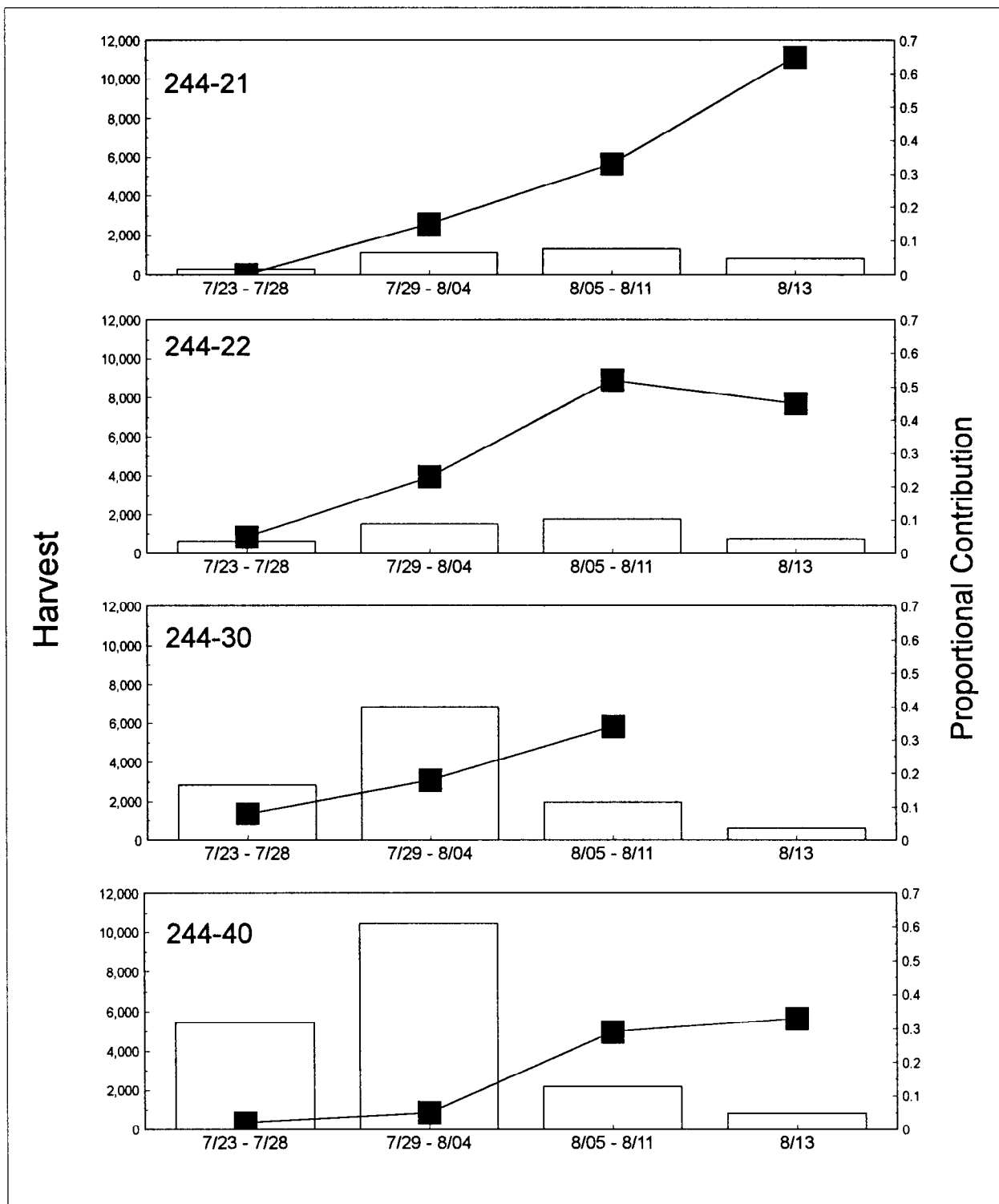


Figure 18. Trend in proportional contribution of Kenai River coho salmon (lines) to the total harvest (bars) occurring in four statistical areas of the Upper Cook Inlet Central District eastside set gill net fishery, 1993.

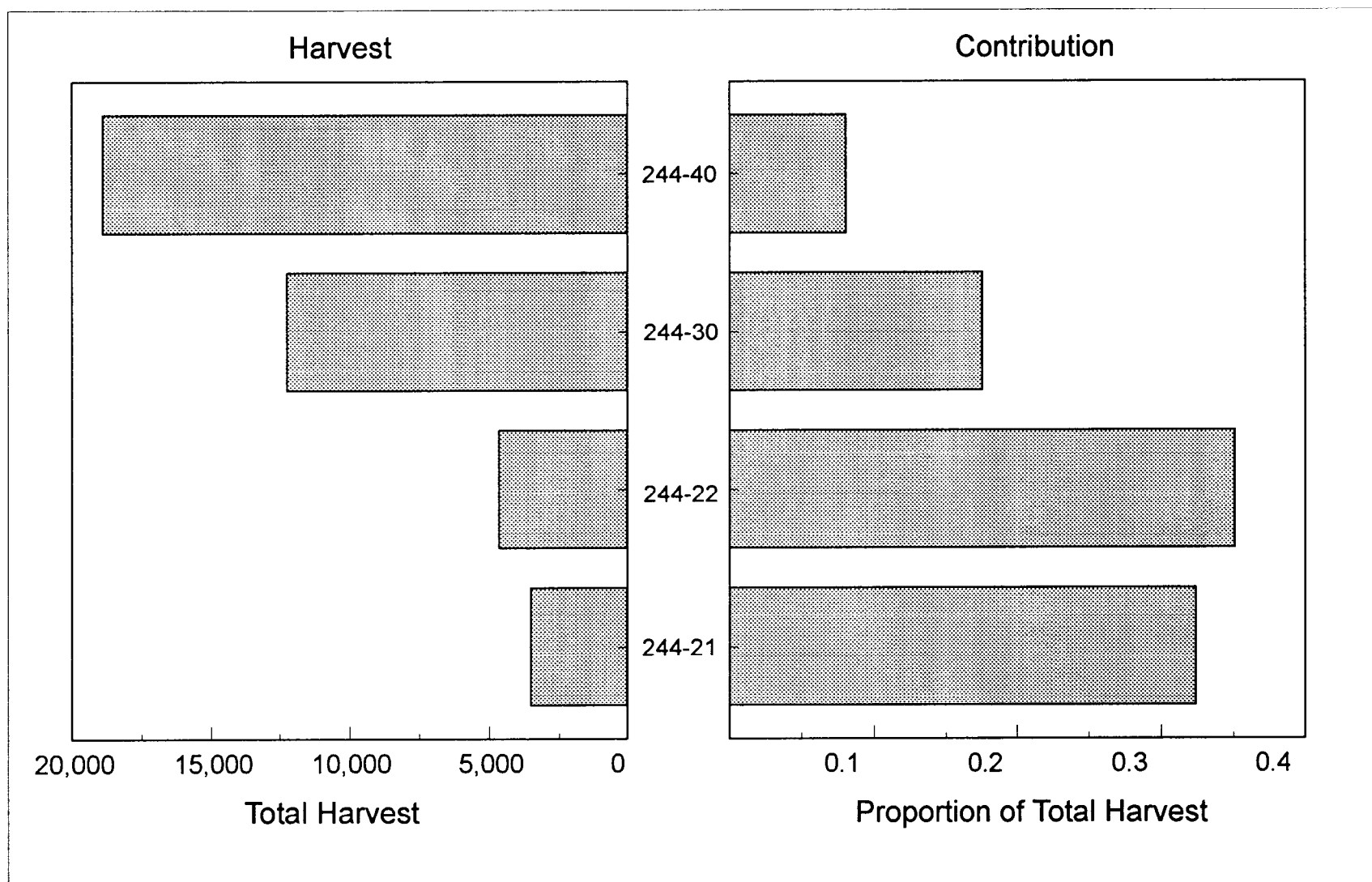


Figure 19. Total harvest and contribution of coho salmon from the Kenai River to harvests occurring in four statistical areas of the Upper Cook Inlet Central District eastside set gill net fishery during the period sampled in 1993.

DISCUSSION

Contribution Estimates

Estimates of the contribution of Kenai River coho salmon to the 1993 Central District drift net and eastside set net fisheries are the first ever available and are lower than expected. Authors developing the stock assessment program postulated that the Kenai River comprised an average 40% of the drift gill net harvest and 70% of the set gill net harvest for planning purposes (Meyer et al. *Unpublished*). Fishery managers have also assumed that the Kenai River contributed substantially to these harvests (Ruesch and Fox 1994). Reasons for the disparity in 1993 are unclear. Although it is possible that the annual contribution of coho salmon from the Kenai River is inherently low, it is more likely that there is a relationship between contribution and the timing of area closures in the fisheries. An analysis of this relationship may provide stock-specific management implications. Such an analysis should be deferred until contribution estimates become available for the 1994 coho salmon harvests to allow a comparison between years.

Without concurrent estimates of both escapement and recreational harvest, it is difficult to put the contribution estimates into perspective because we have no estimate of the exploitation rate imposed on Kenai River fish. However, we can now account for total fishing mortality of Kenai River coho (Table 11). Virtually all commercial harvest occurred in the Central District and was estimated at 7,512 fish. Catch rate information in both the eastside set gill net fishery and the inriver recreational fishery suggest that coho salmon available to these commercial fisheries primarily enter the river in August. A creel survey was used to estimate the lower river recreational harvest at 21,628 (SE = 2,429) fish during August (Schwager-King 1993). Total recreational harvest for the Kenai River drainage was estimated at 52,828 coho salmon (Mills 1994). A total of 1,425 coho salmon were also harvested in a personal use dip net fishery in the mouth of the Kenai River (Mills 1994). Total harvest of Kenai River coho salmon in 1993 was estimated at 61,769 fish. This obviously does not account for escapement, but it provides a point for discussion when hypothesizing the true escapement.

Because marked fish from the Moose River were recovered from the Central District drift gill net fishery on only 6 days, a consequential trend in contribution was not discernible. However, there was an increasing trend in the contribution to harvests in all statistical areas of the eastside set gill net fishery. Coho salmon from the Kenai River accounted for a greater proportion of the harvests later in the season. These fish made a substantial contribution on the last fishery opening on August 13. This strongly suggests that the regulation that closes the fishery by mid-August had its intended effect in 1993 of minimizing the harvest of coho salmon that return to the Kenai River after late August.

In both fisheries, the overwhelming proportion of the harvest was comprised of stocks of unknown origin. Estimates of the contribution of hatchery-produced stocks to these fisheries in 1993 are reported by Hoffmann and Hasbrouck (1994). Contributions of these fish were also low relative to the total harvest occurring during sampled periods (Figure 20). There are a total of 67 stream systems known to support coho salmon in Upper Cook Inlet (ADF&G 1990). The relative contribution of these streams to commercial harvests is unknown.

Table 11. Summary of total fishing mortality of Kenai River coho salmon in Upper Cook Inlet, 1993.

Fishery	Component	Harvest	
Central District Drift Gill Net	7/12 - 8/9; 95% of Total Harvest	1,040	^a
Central District East Side Set Gill Net	7/23 - 8/13; 91% of Total Harvest	<u>6,472</u>	^a
Total Commercial Harvest		7,512	^a
Kenai River Recreational	August; Lower River	21,628	^b
Kenai River Recreational - Total Harvest		52,828	^{c,d}
Kenai River Personal Use Dip Net	Total Harvest	1,429	^c
Total Harvest of Kenai River Coho Salmon		61,769	

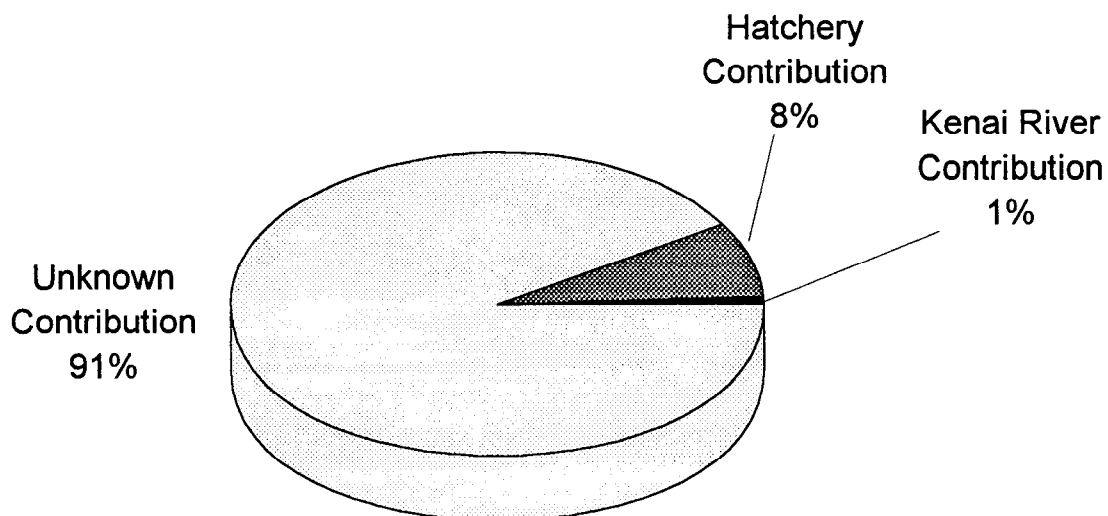
^a Harvest estimated from CWT program (this report).

^b Harvest estimated from creel survey (Schwager-King 1993).

^c Harvest estimated from postal survey (Mills 1994).

^d Includes estimated harvest from lower river in August (Schwager-King 1993).

Central District Drift Net Harvest



Central District East Side Set Net Harvest

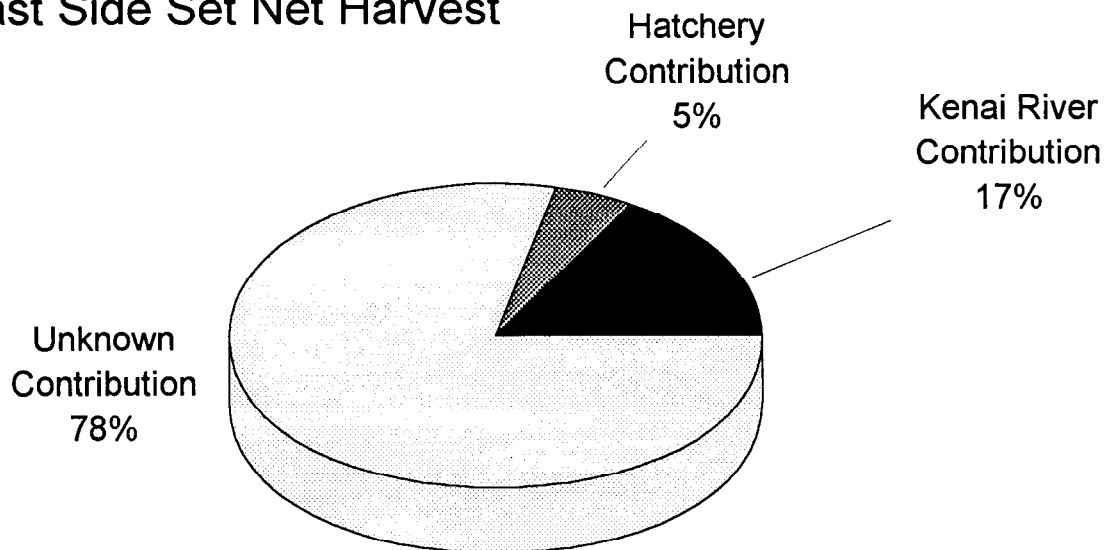


Figure 20. Contribution of coho salmon of known origin to the 1993 drift gill net and eastside set gill net harvests in the Central District of Upper Cook Inlet during the period when the harvest was examined.

Considering the lower than expected contribution from Kenai River stocks, it may be prudent to expand the current study to include the assessment of other contributing stocks in the future.

During the sampled period, there was an increasing trend in proportional contribution and a decreasing trend in total harvest from the northernmost statistical area to the southernmost. Over 90% of the harvest that occurred in the northernmost statistical area consisted of fish of other than Kenai River origin. Hatchery-released coho salmon contributed more fish to the harvest in this statistical area than did the Kenai River. Because these hatchery cohorts were bound for release locations in the Northern District, it is likely that other northern-bound fish contributed as well. A second set of contribution estimates will indicate if this pattern of contribution is consistent between years.

Clark and Bernard (1987) present equations for calculating the number of marked fish required to achieve desired relative precision levels for contribution estimates. The initial smolt marking objective for the Kenai River was based on an *a priori* smolt abundance estimate of 4 million, contributions to the drift and set net harvests of 40% and 70%, respectively, and a commercial harvest sampling fraction of 15% (Meyer et al. *Unpublished*). These *a priori* estimates of smolt abundance and contribution were high relative to results presented in this report. Regardless of the new information presented, new marking objectives should not be calculated until a second set of contribution and smolt estimates become available. The 1993 smolt and 1994 contribution estimates will be available early in 1995. Two seasons of estimates will provide more complete information with which to refine marking objectives.

The objective of commercial sampling in 1993 was to examine 15% of the drift gill net and eastside set gill net harvests in the Central District. This was exceeded in both fisheries. However, this objective was also set using the same *a priori* estimates used to calculate the smolt marking objective. The level of commercial harvest sampling should also be re-evaluated when the 1994 contribution estimates become available.

While no change in the marked proportion was detected in the recreational inriver harvest over 2-week intervals, testing among 1-week intervals did detect a change. The difference was partially due to a low marked proportion during the first week of August. This may have been due to the low sample size examined during that week. If two more tags had been recovered, the test would not have detected a change over the eight 1-week periods. If the difference was real, however, and the true proportion of the cohort marked was slightly lower during the early portion of the season as fish passed through the commercial fishery, then pooling the inriver recovery data over all weeks would result in an overestimate of the marked proportion for the group of fish returning earliest. The end result would be that the contribution estimates would be biased low. However, considering the estimate of contribution of coho salmon from the Kenai River was low relative to the total commercial harvests, the consequence of such a bias is minimal.

Juvenile Marking

The marking of coho salmon smolt at the Moose River was an effective strategy for obtaining a marked population to estimate commercial contribution.

Sufficient numbers were recovered from the inriver recreational harvest to estimate the marked proportion of the cohort. In addition, the consistency of the marked proportion during August and September indicates that smolt emigrating from the Moose River are representative of Kenai River stocks with respect to return timing.

The marking of smolt emigrating from Hidden Creek in 1992 and the marking of fingerling rearing at the outlet of Skilak Lake in 1991 were ineffective for obtaining a marked population. Relatively few fish were recovered from commercial harvests or from the inriver recreational harvest. Also, the timing of recovered fish was not constant during August and September. The marking of fish at these locations has been discontinued in favor of marking solely at the Moose River.

Tagging studies (Carlson 1992) indicate that rearing juveniles migrated into the Moose River system from other areas in the Kenai River drainage. The cumulative effect of movement into the system was that the rearing population consisted of a mixture of fish exhibiting the wide range of return timings characteristic of Kenai River coho salmon. Also, the count of smolt emigrating from the Moose River in 1992 represented about 16% of the estimated total Kenai River smolt abundance of about 1 million. The Moose River is therefore of considerable importance to coho salmon production in the Kenai River drainage.

It should be noted that the smolt estimate is biased high. The estimate was based on tag recoveries from 336 fish marked at the Moose River but does not account for any smolt-to-adult tag loss. If it were possible to correct for tag loss, the smolt estimate for the Kenai River would be lower than one million. However, this project was not designed to estimate smolt abundance and the estimate is considered useful for setting smolt marking goals for future releases. In 1995, only fish marked at the Moose River will return as adults because marking at other locations was discontinued in 1993. During 1995, it will be possible to estimate and correct for such a tag loss.

The long-term tag loss rate measured among all adults recovered from the inriver recreational harvest was 9%. This loss rate was not high enough to jeopardize the ability to calculate contribution estimates. However, tagging procedures used in 1992 have been updated following recommendations of L. Peltz (Alaska Department of Fish and Game, Palmer, personal communication). Different tag injector head positioning jigs were used to tag smolt in 1993 and 1994 to reduce the variation in tag implantation depth relative to fish size in an effort to improve long-term tag retention. Comparing tag loss between years will test the benefits of tagging a cohort of fish with a variety of positioning jigs.

RECOMMENDATIONS

1. Continue contribution project until total return information becomes available.

Contribution estimates should continue to be made on an annual basis as part of the Kenai River stock assessment program. The estimates are a key piece needed to reconstruct total annual returns. Until estimates of

spawning escapements become available, a series of contribution estimates will aid in commercial fishery management decisions and refinement of fish marking objectives.

2. Continue marking coho salmon smolt at the Moose River.

In 1992, the Moose River provided an abundant source of smolt that were representative of Kenai River coho salmon.

3. Reevaluate juvenile marking and adult recovery objectives.

Allocation of funds between smolt marking and adult recovery efforts should be optimized based on new estimates of smolt abundance and contribution. Marking and recovery objectives should be based on information obtained during the 1993 and 1994 return years. The evaluation should be completed before smolt marking begins in the spring of 1995.

4. Investigate the relationship between contribution and timing of fishery area closures.

This will provide fishery managers with a new source of information with which to evaluate the effect of management actions on the harvest of coho salmon of Kenai River origin.

ACKNOWLEDGMENTS

The authors would like to thank the individuals who assisted with this project. Jerry Strait provided training for project staff in the use of coded wire tagging equipment. He and Jeff Breakfield functioned as crew leaders and provided the logistical support needed to operate remote field facilities. Kurt Strausbaugh, Gordon Shuler, and Patti Berkahn also provided logistical support and assisted with handling and marking fish. Larry Larson designed the Moose River weir and provided logistical support during installation and operation.

The commercial harvest was examined by technicians of the Commercial Fisheries Management and Development Division. Dave Waltemyer and Kim Rudge supervised commercial harvest sampling, provided logistical support, and collated commercial sampling data. Ed Borden, Jenny Johnson, Rob Massengill, Mike Houghton, and Patti Berkahn sampled the recreational harvest. Mary Schwager-King supervised recreational sampling. Terry Bendock and Steve Hammarstrom provided guidance, insight, and logistical support throughout the project. Scott Meyer, Doug Vincent-Lang, and Doug McBride provided the vision to initiate the project. Additional support was provided by the Sport Fish Division staff in Soldotna. Personnel at the CFMDD Coded Wire Tag Processing Laboratory processed all tag recoveries and provided recovery data files.

Jim and Jane Fellman and family granted convenient access to the Moose River as did Bill West. Jeff and Pam Breakfield and family granted convenient access to the Kenai River.

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APPENDIX

Appendix A1. Sources of marked coho salmon adults recovered from the Kenai River recreational harvest during August through September 1993, as determined from coded wire tags.

Sample Type	Recovery Date	Number Examined	Number of Marked Fish Observed	Number of Marked Fish Recovered	CWT Missing	Release Location and Year for Decodable CWT's				
						Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Homer Spit 1992	Ship Creek 1992
Random	08/01	6								
	08/02	4								
	08/03	10	1	1			1			
	08/04	2								
	08/05	15	1	1		1				
	08/06	92	6	4	1	2	1			
	08/07	38	3	3		3				
	08/08	45	3	3	1	2				
	08/09	68	5	5		5				
	08/10	59	10	9		8	1			
	08/11	124	13	13	1	12				
	08/12	78	8	4		3	1			
	08/13	21	4	4		2	2			
	08/14	57	4	4		4				
	08/15	45	7	6	1	3	2			
	08/16	107	10	9		9				
	08/17	181	15	15	1	11	2	1		
	08/18	177	15	14	3	8	2	1		
	08/19	86	8	8		8				
	08/20	33	4	4		3	1			
	08/21	57	8	8	3	4	1			
	08/22	172	14	14	1	13				
	08/23	151	28	26	1	20	5			
	08/24	225	27	27	2	23	2			
	08/25	103	8	8	2	5	1			
	08/26	43	2	2		2				
	08/27	81	6	6	1	5				
	08/28	162	13	12	2	9	1			
	08/29	59	7	4		3		1		
	08/30	32	4	4		4				
	08/31	76	7	7	1	6				
August Total		2,409	241	225	21	178	23	3		

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Appendix A1. (Page 2 of 4).

Sample Type	Recovery Date	Number Examined	Number of Marked Fish Observed	Number of Marked Fish Recovered	CWT Missing	Release Location and Year for Decodable CWT's				
						Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Homer Spit 1992	Ship Creek 1992
Random	09/01	39	2	2		2				
	09/02	70	11	10		9	1			
	09/03	115	15	12	2	9		1		
	09/04	17	5	5	2	3				
	09/05	42	7	6		6				
	09/06	58	6	6		6				
	09/07	41	5	5		5				
	09/08	127	9	9	1	7		1		
	09/09	65	9	7		7				
	09/10	124	22	11		10	1			
	09/11	143	20	17		15		1		1
	09/12	60	3	2		2				
	09/13	17	1	1			1			
	09/14	17	2	1		1				
	09/15	35	3	3	1	2				
	09/16	47	6	6	1	4	1			
	09/17	134	14	9	2	7				
	09/18	209	19	18	2	13	2	1		
	09/19	143	13	8		6	1		1	
	09/20	130	10	7	1	5	1			
	09/21	17	2	1		1				
	09/22	49	9	9		8	1			
	09/23	139	9	5		5				
	09/24	157	15	12	4	8				
	09/25	100	8	7		7				
	09/26	18	3	3		3				
	09/27	37	2	2		2				
	09/28	12	1	1		1				
	09/29	40	4	4	1	3				
	09/30	15	1	1		1				
September Total		2,217	236	190	17	158	9	4	1	1
Random Grand Total		4,626	477	415	38	336	32	7	1	1

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Appendix A1. (Page 3 of 4).

Sample Type	Recovery Date	Number Examined	Number of Marked Fish Observed	Number of Marked Fish Recovered	CWT Missing	Release Location and Year for Decodable CWT's				
						Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Homer Spit 1992	Ship Creek 1992
Non- Random ¹	08/01									
	08/02									
	08/03									
	08/04									
	08/05			1		1				
	08/06			1			1			
	08/07									
	08/08									
	08/09			4		4				
	08/10			3		3				
	08/11									
	08/12									
	08/13			4	1	3				
	08/14			1		1				
	08/15			3	1	2				
	08/16			2	1	1				
	08/17			4		2	2			
	08/18			3		3				
	08/19			4		3	1			
	08/20			1		1				
	08/21			1		1				
	08/22			3		2	1			
	08/23			8	1	4	2	1		
	08/24			10		7	3			
	08/25			5	1	2	1	1		
	08/26			3		3				
	08/27			7	1	5	1			
	08/28 ²			5	1	3				
	08/29			2	1	1				
	08/30									
	08/31									
August Total				75	8	44	11	2		

-continued-

Appendix A1. (Page 4 of 4).

Sample Type	Recovery Date	Number Examined	Number of Marked Fish Observed	Number of Marked Fish Recovered	CWT Missing	Release Location and Year for Decodable CWT's				
						Moose River 1992	Skilak Lake 1991	Hidden Creek 1992	Homer Spit 1992	Ship Creek 1992
Non-Random ¹	09/01			6		6				
	09/02			2		2				
	09/03									
	09/04			8	2	6				
	09/05									
	09/06			1			1			
	09/07			2		1	1			
	09/08			2		2				
	09/09									
	09/10			7	1	6				
	09/11			3	1	2				
	09/12			2		2				
	09/13			1			1			
	09/14			6		6				
	09/15									
	09/16									
	09/17			4		4				
	09/18			5	1	4				
	09/19			1			1			
	09/20			1		1				
	09/21			5	2	3				
	09/22									
	09/23			10	3	7				
	09/24			3		3				
	09/25			1		1				
	09/26									
	09/27									
	09/28									
	09/29									
	09/30			1			1			
September Total				71	10	56	5			
Non-Random Grand Total				146	18	100	16	2		

¹ Non-Random recoveries are voluntary angler returns to ADF&G personnel and are not used in quantitative calculations.

² One of the four CWT's recovered on 8/28/93 was unreadable.

Appendix A2. Kenai River recreational harvest recoveries in 1993 of coho salmon adults marked as smolt early in the emigration and late in the emigration from Moose River in 1992.

Date of	Last Date on Which Each Unique Tag Code was Injected															
Adult	Early Smolt							Late Smolt								
Recovery	5/25/92	5/28/92	5/29/92	5/31/92	6/1/92	6/1/92	6/3/92	6/4/92	6/5/92	6/6/92	6/10/92	6/12/92	6/14/92	6/20/92	6/25/92	ALL
8/5/93			1													1
8/6/93													1	1		2
8/7/93			1	2												3
8/8/93												2				2
8/9/93											1	2		2		5
8/10/93				2	2			1		2		1				8
8/11/93			1	1	1	1		2	1	1	2	2				12
8/12/93			1								1			1		3
8/13/93			1			1										2
8/14/93	1						1					2				4
8/15/93		1		1								1				3
Period Total	1	1	5	6	4	1	1	3	1	3	4	10	1	4		45
8/16/93			1	1			2		2			2			1	9
8/17/93	1	2	1	2				1	1	1	1			1		11
8/18/93		1	2	1	1					2		1				8
8/19/93		1	1							2	1			3		8
8/20/93					1			1						1		3
8/21/93							1	1	1	1						4
8/22/93		2	1				2	2		2		1	2		1	13
8/23/93		1	1	3	2		1	4		1	2	3		1	1	20
8/24/93			2	1	4		2	1	2	4	1	1	1	3	1	23
8/25/93					1		3						1			5
8/26/93			1										1			2
8/27/93			2		2						1					5
8/28/93		2	1	1			1		1			1	2			9
8/29/93								1		1			1			3
8/30/93							1			1			1	1		4
8/31/93		1		1					1		1	1			1	6
Period Total	1	10	13	10	11		13	11	8	15	7	10	9	10	5	133

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Date of Adult Recovery	Last Date on Which Each Unique Tag Code was Injected															ALL
	Early Smolt							Late Smolt								
	5/25/92	5/28/92	5/29/92	5/31/92	6/1/92	6/1/92	6/3/92	6/4/92	6/5/92	6/6/92	6/10/92	6/12/92	6/14/92	6/20/92	6/25/92	
9/1/93							1	1								2
9/2/93				3			1	3				1	1			9
9/3/93			3		1		1		1		1	1		1		9
9/4/93			1						1					1		3
9/5/93		2		1				1			1			1		6
9/6/93		1						1				2		1	1	6
9/7/93			1	1	1					1		1				5
9/8/93		1	1	2			1	1						1		7
9/9/93		1	1	1	2				1				1			7
9/10/93		3		1				1	1		2			1	1	10
9/11/93			1	1	3		1	7		2						15
9/12/93		1	1													2
9/13/93																
9/14/93			1													1
9/15/93	1	1														2
Period Total	1	10	10	10	7		5	15	4	3	4	5	2	6	2	84
9/16/93		1									3					4
9/17/93		2		1	1			2			1					7
9/18/93	1	2	4		1		1		1	2	1					13
9/19/93							1	2	1	1		1				6
9/20/93		1			1		2			1						5
9/21/93												1				1
9/22/93		1		2	1					3			1			8
9/23/93		1			1		1	1	1							5
9/24/93			2	1	3								1	1		8
9/25/93			1					2	1	1		1	1			7
9/26/93		1					1						1			3
9/27/93							1			1						2
9/28/93				1												1
9/29/93			1									1	1			3
9/30/93			1													1
Period Total	1	9	9	5	8		7	7	4	9	5	4	5	1		74
Season Total	4	30	37	31	30	1	26	36	17	30	20	29	17	21	7	336

Appendix A3. Number of marked coho salmon recovered by release location and number examined by date, statistical area, and fishery area for Upper Cook Inlet commercial fisheries, 1993.¹

District	Fishery	Statistical Area	Date	Number Examined	Ad-clips Found	Heads Recovered	No Tag	Big Lk System 1990	Bird Creek 1992	Campbell Creek 1992	Cottonwood Creek 1992	Crooked Creek 1992	Fish Creek 1992	Hidden Creek 1992	Homer Spit 1992	Little Susitna R 1990	Little Susitna R 1992	Mill 25 River 1990	Moose River 1992	Nancy Lake 1991	Ship Creek 1992	Skilak Lake 1991	Skilak Lake 1992	Wasilla Creek 1992
Central	Chinitna Bay	24510	9/3/93	148	1	1	1																	
	Chinitna Bay Total			148	1	1	1																	
Central	Drift	244	7/12/93	795	8	8	5		1	1							1							
Central	Drift	244	7/13/93	29	1	1	1																	
Central	Drift	244	7/14/93	161	4	4	3										1							
Central	Drift	244	7/16/93	1,495	23	22	9		6	2						1	4							
Central	Drift	244	7/17/93	256	3	3	1		1							1								
Central	Drift	244	7/18/93	177	5	5	1			1							3							
Central	Drift	244	7/19/93	4,191	49	49	13		12	10						2	12							
Central	Drift	244	7/20/93	218	1	1											1							
Central	Drift	244	7/21/93	428	13	13	4		5	2							2							
Central	Drift	244	7/22/93	322	3	3	3																	
Central	Drift	244	7/23/93	6,233	124	124	24		32	34	1					2	28							1
Central	Drift	244	7/26/93	4,691	107	107	22		21	32						4	27		1					
Central	Drift	244	7/27/93	401	15	15	4		4	4							3							
Central	Drift	244	7/28/93	993	29	29	3		8	10						1	6		1					
Central	Drift	244	7/29/93	1,099	42	42	10		6	9						1	14		2					
Central	Drift	244	7/30/93	7,938	234	234	39		55	55			2	1		7	62		11	1				1
Central	Drift	244	8/2/93	3,252	90	90	20		22	17		1		1		2	20		6					1
Central	Drift	244	8/3/93	59																				
Central	Drift	244	8/4/93	13	1	1			1															
Central	Drift	244	8/6/93	206	2	2				1							1							
Central	Drift	244	8/9/93	655	15	15	3		4	4						1	2							1
	Drift Total			33,612	769	768	165		178	182	1	1	2	2		22	187		23	1				4
Central	Drift, West Side Only	Unknown	8/30/93	129																				
	Unknown Total			33,741	769	768	165		178	182	1	1	2	2		22	187		23	1				4
Central	Drift, West Side Only	24570	8/20/93	73																				
	24570 Total			73																				
Central	Drift, West Side Only	24590	8/23/93	180	1	1	1																	
Central	Drift, West Side Only	24590	8/27/93	363																				
	24590 Total			543	1	1	1																	
	Drift, West Side Only Total			745	1	1	1																	
Central	East Side Set	Unknown	7/23/93	1																				
Central	East Side Set	Unknown	7/26/93	117	4	4			2	1							1							
Central	East Side Set	Unknown	8/2/93	38	3	3	2																	
Central	East Side Set	Unknown	8/3/93	208	11	11	4		1	1									4			1		
Central	East Side Set	Unknown	8/6/93	160	14	14	1		4								1		4			4		
Central	East Side Set	Unknown	8/13/93	25	1	1													1					
	Unknown Total			549	33	33	7		7	2							2		10			5		
Central	East Side Set	24421	7/23/93	25																				
Central	East Side Set	24421	7/26/93	18																				
Central	East Side Set	24421	7/30/93	30	1	1																		
Central	East Side Set	24421	8/2/93	105	5	5	1					2					1							
Central	East Side Set	24421	8/6/93	249	16	16	3		1	2									10					
Central	East Side Set	24421	8/9/93	38																				
Central	East Side Set	24421	8/13/93	338	23	23									1				16			1	1	
	24421 Total			803	45	45	4		1	2		6			1		1		28			1	1	
Central	East Side Set	24422	7/23/93	46	1	1																		
Central	East Side Set	24422	7/26/93	90	1	1																		
Central	East Side Set	24422	7/30/93	114	6	6	1																	
Central	East Side Set	24422	8/2/93	146	9	9	1			1														
Central	East Side Set	24422	8/6/93	199	10	10			2															
Central	East Side Set	24422	8/9/93	149	9	9			1															
Central	East Side Set	24422	8/13/93	121	11	11	3					2		1					4			1		
	24422 Total			865	47	47	5		3	1		2		1			4		27			4		

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District	Fishery	Statistical Area	Date	Number Examined	Ad-clips Found	Heads Recovered	No Tag	Big Lk System 1990	Bird Creek 1992	Campbell Creek 1992	Cottonwood Creek 1992	Crooked Creek 1992	Fish Creek 1992	Hidden Creek 1992	Homer Spit 1992	Little Susitna R 1990	Little Susitna R 1992	Mile 25 1990	Moose River 1992	Nancy Lake 1991	Ship Creek 1992	Skilak Lake 1991	Skilak Lake 1992	Wanilla Creek 1992
Central	East Side Set	24430	7/23/93	18															2					
Central	East Side Set	24430	7/26/93	128	2	2													1					
Central	East Side Set	24430	7/27/93	91	3	3	1												1					
Central	East Side Set	24430	7/28/93	242	7	7	1		1	2							2		1					
Central	East Side Set	24430	7/29/93	504	11	11	4			4				2								1		
Central	East Side Set	24430	7/30/93	92	4	4						1							2			1		
Central	East Side Set	24430	8/2/93	276	9	9	1					1							6			1		
Central	East Side Set	24430	8/3/93	231	6	6			1			1					1		3					
Central	East Side Set	24430	8/4/93	424	27	27	2		1	1		1		1			4		15			2		
Central	East Side Set	24430	8/6/93	66	3	3	1										1				1			
Central	East Side Set	24430	8/7/93	70	2	2													2					
Central	East Side Set	24430	8/9/93	168	8	8						1							6			1		
24430 Total				2,310	82	82	10		3	7		5		3			9		38		1	6		
Central	East Side Set	24440	7/23/93	66													1							
Central	East Side Set	24440	7/26/93	251	2	2	1																	
Central	East Side Set	24440	7/27/93	112	2	2			1													1		
Central	East Side Set	24440	7/28/93	973	24	24	5		9	5						1	1		3					
Central	East Side Set	24440	7/29/93	184	4	4	1		2	1														
Central	East Side Set	24440	7/30/93	685	23	23	4		3	7						1	3		3					2
Central	East Side Set	24440	8/1/93	300	12	12	4	1	2	3									2					
Central	East Side Set	24440	8/2/93	222	7	7			3	1							3							
Central	East Side Set	24440	8/3/93	371	19	19	5		4	4							3		1			1		
Central	East Side Set	24440	8/4/93	452	21	21	4		2	2						1	4		7			1		
Central	East Side Set	24440	8/6/93	539	23	23	3		2	4		1					1		7			5		
Central	East Side Set	24440	8/7/93	357	19	19	2			3		1					4		9					
Central	East Side Set	24440	8/9/93	265	15	15	2							1			4		7			1		
Central	East Side Set	24440	8/13/93	165	6	6	2												4					
24440 Total				4,942	177	177	33	1	28	30		2		1		4	24		42			9		2
East Side Set Total				9,469	384	384	59	1	42	42		15		5	1	4	40		146		1	25	1	2
Central	Kalgin Is. Set	Unk.	8/11/93	984	22	22	6		2	5						1	6		2					
Central	Kalgin Is. Set	Unk.	8/16/93	797	10	10	3		2	2		1					1				1			
Central	Kalgin Is. Set	Unk.	8/23/93	177	3	3						2									1			
Kalgin Is. Set Total				1,958	35	35	9		4	7		3				1	7		2			2		
Central	West Side Set	Unk.	8/30/93	959	1	1									1									
Unknown Total				2,917	36	36	9		4	7		3			1	1	7		2			2		
Central	West Side Set	24520	8/23/93	96									1									1		
Central	West Side Set	24520	8/27/93	608	4	4	2																	
Central	West Side Set	24520	9/6/93	102																		1		
Central	West Side Set	24520	9/13/93	103	1	1																		
24520 Total				909	5	5	2					1										2		
West Side Set Total				1,868	6	6	2					1			1							2		
Northern	East Side Set	24770	7/16/93	130	1	1			1															
Northern	East Side Set	24770	7/26/93	246	7	7	4		1									2						
Northern	East Side Set	24770	7/30/93	207	11	11	2		5	4														
Northern	East Side Set	24770	8/2/93	485	37	37	6		15	11	1					2	1				1			
Northern	East Side Set	24770	8/6/93	72	5	5	1		3	1														
Northern	East Side Set	24770	8/13/93	216	17	17	2		7	6							2							
Northern	East Side Set	24770	8/20/93	140	7	7	3		3	1														
Northern	East Side Set	24770	8/23/93	324	11	11	1		3	2		1					1		1		2			
Northern	East Side Set	24770	8/27/93	572	9	9	1		2	1											5			
Northern	East Side Set	24770	8/30/93	518	20	20	4	1	4	1	1						1				8			
Northern	East Side Set	24770	9/3/93	267	11	11	1		1										1		9			
Northern	East Side Set	24770	9/10/93	306	42	42	8														33			
Northern	East Side Set	24770	9/13/93	75	10	10	1		2												7			
24770 Total				3,558	188	188	34	1	47	27	2	1				2	7		2		65			

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District	Fishery	Statistical Area	Date	Number Examined	Ad-clips Found	Heads Recovered	No Tag	Big Lk System 1990	Bird Creek 1992	Campbell Creek 1992	Cottonwood Creek 1992	Crooked Creek 1992	Fish Creek 1992	Hidden Creek 1992	Homer Spit 1992	Little Susitna R 1990	Little Susitna R 1992	Mile 25 1990	Moose River 1992	Nancy Lake 1991	Ship Creek 1992	Skilak Lake 1991	Skilak Lake 1992	Wasilla Creek 1992
24780 Total				2,350	6	6	2						1				1				2			
Northern	East Side Set	24780	7/26/93	20																				
Northern	East Side Set	24780	8/2/93	28	2	2							1				1							
Northern	East Side Set	24780	8/13/93	242																				
Northern	East Side Set	24780	8/23/93	598	2	2	1														1			
Northern	East Side Set	24780	8/27/93	447																				
Northern	East Side Set	24780	8/30/93	179	1	1	1																	
Northern	East Side Set	24780	9/3/93	769																				
Northern	East Side Set	24780	9/10/93	67	1	1															1			
Northern	East Side Set	24790	7/19/93	66																				
Northern	East Side Set	24790	7/26/93	19																				
Northern	East Side Set	24790	8/2/93	47																				
Northern	East Side Set	24790	8/27/93	1,210	6	6	1		1	2												2		
Northern	East Side Set	24790	8/30/93	537	1	1															1			
Northern	East Side Set	24790	9/3/93	540	1	1	1																	
Northern	East Side Set	24790	9/10/93	97	1	1	1																	
Northern	East Side Set	24790	9/13/93	31	2	2						1									1			
24790 Total				2,547	11	11	3		1	2		1									4			
East Side Set Total				8,455	205	205	39	1	48	29	2	2	1			2	8		2		71			
Northern	Fire Is. Set	24743	7/16/93	4																				
Northern	Fire Is. Set	24743	7/19/93	170	4	4	1		1	2														
Northern	Fire Is. Set	24743	7/26/93	865	45	45	3		12	14							1	15						
Northern	Fire Is. Set	24743	7/30/93	264	16	16	2		1	8	1							4						
Northern	Fire Is. Set	24743	8/2/93	1,552	84	84	11		17	37	3		1			2	11							2
Northern	Fire Is. Set	24743	8/6/93	1,315	64	64	12		7	25			2			2	14				1			1
Northern	Fire Is. Set	24743	8/9/93	586	39	39	6		14	11						1	6							1
Northern	Fire Is. Set	24743	8/14/93	1,372	145	145	34	3	40	47			2			1	12				2			4
Northern	Fire Is. Set	24743	8/16/93	177	11	11	5	1	1	1							2							1
Northern	Fire Is. Set	24743	8/20/93	143	9	9	3		2	3						1								
24743 Total				6,448	417	417	77	4	95	148	4		5			8	64				3			9
Fire Is. Set Total				6,448	417	417	77	4	95	148	4		5			8	64				3			9
Northern	Knik Arm Set	24750	7/18/93	38	1	1																		
24750 Total				38	1	1																		
Knik Arm Set Total				38	1	1																		
Northern	Unknown	Unknown	7/19/93	902	3	3	2																	
Northern	Unknown	Unknown	7/26/93	1,141	7	7	1			1														
Northern	Unknown	Unknown	7/30/93	1,778	14	14	4		2	4														
Northern	Unknown	Unknown	8/2/93	935	11	11	2		2	3														
Northern	Unknown	Unknown	8/6/93	526	13	13	1		1	5														
Northern	Unknown	Unknown	8/9/93	698	22	22	7		6	4	1			1										
Northern	Unknown	Unknown	8/16/93	2,791	58	58	17		17	10						1	6				6			1
Northern	Unknown	Unknown	8/23/93	860	8	8			1	1							1							1
Northern	Unknown	Unknown	9/6/93	227	4	4	2																	
Northern	Unknown	Unknown	9/10/93	93	4	4				1														
Unknown Total				9,951	144	144	36		29	29	1				1	2	28		5		11			2
Northern	Pt. McKenzie Set	24742	7/16/93	58																				
Northern	Pt. McKenzie Set	24742	7/19/93	29																				
Northern	Pt. McKenzie Set	24742	7/30/93	907	34	34	4		6	9														
Northern	Pt. McKenzie Set	24742	8/2/93	1,173	58	58	13		5	13						2	12		1					
Northern	Pt. McKenzie Set	24742	8/6/93	415	30	29	7	2	4	5	1		3			1	23							
Northern	Pt. McKenzie Set	24742	8/9/93	512	28	28	5		2	9						3	6							
Northern	Pt. McKenzie Set	24742	8/13/93	731	41	41	6	1	6	15			1			1	10							1
24742 Total				3,825	191	190	35	3	23	51	1		5			11	58		1					1
Pt. McKenzie Set Total				3,825	191	190	35	3	23	51	1		5			11	58		1					1
Northern	West Side Set	24710	8/9/93	294	2	2				1														
24710 Total				294	2	2				1														

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District	Fishery	Statistical Area	Date	Number Examined	Ad-clip Found	Heads Recovered	No Tag	Big Lk System 1990	Bird Creek 1992	Campbell Creek 1992	Cottonwood Creek 1992	Crooked Creek 1992	Fish Creek 1992	Hidden Creek 1992	Homer Spit 1992	Little Susitna R 1990	Little Susitna R 1992	Mile 25 1990	Moose River 1992	Nancy Lake 1991	Ship Creek 1992	Skilak Lake 1991	Skilak Lake 1992	Wasilla Creek 1992
Northern	West Side Set	24720	8/9/93	704	16	16	8		1	2							5							
Northern	West Side Set	24720	8/16/93	664	10	10	4		1	3							2							
		24720 Total		1,368	26	26	12		2	5							7							
Northern	West Side Set	24730	8/14/93	1,298	48	48	14		9	10						1	13		1					
		24730 Total		1,298	48	48	14		9	10						1	13		1					
Northern	West Side Set	24741	7/16/93	151	5	5	2		1	2														
Northern	West Side Set	24741	7/19/93	106	2	2											2							
Northern	West Side Set	24741	7/26/93	305	13	13	4		2	1							6							
Northern	West Side Set	24741	7/30/93	663	18	18	2		2	6						1	6							1
Northern	West Side Set	24741	8/2/93	895	33	33	7			7						5	9		1					4
Northern	West Side Set	24741	8/6/93	487	21	21	7		2	1						4	7							
Northern	West Side Set	24741	8/9/93	185	11	11	2		2	2							5							
Northern	West Side Set	24741	8/13/93	261	15	15	2		3	4	1		1				4							
Northern	West Side Set	24741	8/16/93	96	5	5	2		1	1						1								
		24741 Total		3,149	123	123	28		13	24	1		1			11	39		1					5
		West Side Set Total		6,109	199	199	54		24	40	1		1			12	60		2					5
Unknown	Unknown	Unknown	8/2/93	73	5	5	1		1	2							1							
		Unknown Total		73	5	5	1		1	2							1							
		Grand Total		82,699	2,338	2,336	479	9	444	530	10	22	14	8	2	62	454	1	180	1	90	25	1	23

¹ All release locations outside the Kenai River involve hatchery-produced coho salmon. All locations listed are located in Cook Inlet with the exception of the Mile 25 location which is located near Valdez, Alaska.

² One of the 41 tags recovered on 8/13 was retrieved from the head, but was lost before it could be read.

Appendix A4. Daily harvest, proportion of harvest examined, and recoveries of marked coho salmon from the Upper Cook Inlet Central District eastside set gill net fishery by statistical area, 1993.¹

Opening Dates 244-21	Harvest	Number Examined	Proportion Examined	Ad-clips Found	Sources of Ad-clipped Fish		
					Moose River 1992	No Tag	Other Sources ²
6/28							
7/02	16						
7/05	3						
7/08	4						
7/09							
7/12	4						
7/13	8						
7/14	8						
7/16	33						
7/17	19						
7/18	41						
7/19	37						
7/20	38						
7/21	30						
7/22	Closed						
7/23	80	25	0.31	0			
7/24	Closed						
7/26	190	18	0.09	0			
7/27	Closed						
7/28	Closed						
7/29	Closed						
7/30	281	30	0.11	1	1	0	0
7/31	506						
8/01	Closed						
8/02	322	105	0.33	5	1	1	3
8/03	Closed						
8/04	Closed						
8/06	776	249	0.32	16	10	3	3
8/07	Closed						
8/09	529	38	0.07				
8/13	828	338	0.41	23	16	0	7
7/23-8/13 ³	3,512	803	0.23	45	28	4	13
Total	3,753	803	0.21	45	28	4	13

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Appendix A4. (Page 2 of 4).

Opening		Sources of Ad-clipped Fish					
Dates		Number	Proportion	Ad-clips	Moose River		Other
244-22	Harvest	Examined	Examined	Found	1992	No Tag	Sources ²
6/28	0						
7/02	1						
7/05	2						
7/08	4						
7/09	4						
7/12	1						
7/13	9						
7/14	36						
7/16	51						
7/17	46						
7/18	142						
7/19	88						
7/20	42						
7/21	50						
7/22	Closed						
7/23	111	46	0.41	1	1	0	0
7/24	Closed						
7/26	509	90	0.18	1	0	0	1
7/27	Closed						
7/28	Closed						
7/29	Closed						
7/30	316	114	0.36	6	2	1	3
7/31	722						
8/01	Closed						
8/02	474	146	0.31	9	6	1	2
8/03	Closed						
8/04	Closed						
8/06	1,203	199	0.17	10	6	0	4
8/07	Closed						
8/09	562	149	0.27	9	8	0	1
8/13	759	121	0.16	11	4	3	4
7/23-8/13 ³	4,656	865	0.19	47	27	5	15
Total	5,132	865	0.17	47	27	5	15

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Appendix A4. (Page 3 of 4).

Opening Dates 244-30	Harvest	Number Examined	Proportion Examined	Ad-clips Found	Sources of Ad-clipped Fish		
					Moose River 1992	No Tag	Other Sources ²
6/28	0						
7/02	0						
7/05	6						
7/08	2						
7/09	1						
7/12	16						
7/13	16						
7/14	77						
7/16	64						
7/17	60						
7/18	118						
7/19	185						
7/20	140						
7/21	140						
7/22	233						
7/23	600	18	0.03	0			
7/24	396	0	0.00				
7/26	550	128	0.23	2	2	0	0
7/27	365	91	0.25	3	1	1	1
7/28	919	242	0.26	7	1	1	5
7/29	1,743	504	0.29	11	0	4	7
7/30	1,079	92	0.09	4	2	0	2
7/31	660	0	0.00				
8/01	692	0	0.00				
8/02	895	276	0.31	9	6	1	2
8/03	610	231	0.38	6	3	0	3
8/04	1,178	424	0.36	27	15	2	10
8/06	440	66	0.15	3	0	1	2
8/07	816	70	0.09	2	2	0	0
8/09	711	168	0.24	8	6	0	2
8/13	608	0	0.00				
7/23-8/13 ³	12,262	2,310	0.19	82	38	10	34
Total	13,320	2,310	0.17	82	38	10	34

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Appendix A4. (Page 4 of 4).

Opening Dates 244-40	Harvest	Number Examined	Proportion Examined	Ad-clips Found	Sources of Ad-clipped Fish		
					Moose River 1992	No Tag	Other Sources ²
6/28	0						
7/02	0						
7/05	3						
7/08	0						
7/09	9						
7/12	38						
7/13	0						
7/14	287						
7/16	193						
7/17	116						
7/18	195						
7/19	322						
7/20	240						
7/21	182						
7/22	382						
7/23	574	66	0.11	0			
7/24	472	0	0.00				
7/26	1,174	251	0.21	2	0	1	1
7/27	983	112	0.11	2	0	0	2
7/28	2,236	973	0.44	24	3	5	16
7/29	2,039	184	0.09	4	0	1	3
7/30	3,023	685	0.23	23	3	4	16
7/31	1,461	0	0.00				
8/01	1,056	300	0.28	12	2	4	6
8/02	1,054	165	0.16	6	4	2	0
8/03	782	222	0.28	7	0	0	7
8/04	1,021	371	0.36	19	1	5	13
8/06	790	452	0.57	21	7	4	10
8/07	704	539	0.77	23	7	3	13
8/09	696	357	0.51	19	9	2	8
8/13	838	265	0.32	15	7	2	6
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7/23-8/13 ³	18,903	4,942	0.26	177	43	33	101
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Total	20,870	4,942	0.24	177	43	33	101

¹ Table includes fish recovered from known statistical areas only. An additional 549 fish were examined in the eastside set gill net fishery, but the statistical area from which the fish were harvested was unknown. See Table 8 for a complete listing of all fish examined in the eastside set gill net harvest.

² Other sources include hatchery-produced coho salmon released at other locations.

³ Period during which the harvest was examined and for which a contribution estimate was calculated.

